

Project Guidelines

ASU Facilities Development & Management

Formerly known as the ASU Design Guidelines

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Foreword

Advice to Architects and Engineers

Your team has been chosen as the architectural/engineering team most qualified to design the project, based upon your ability to effectively communicate and demonstrate to the selection committee your team's design expertise, your understanding of the project, and your commitment to service. In order for your team to successfully exercise the highest degree of design potential afforded by the project, we offer you a few words of advice in the attainment of that goal.

1. Ask Questions

Although your team was chosen as best suited to the project, this may be the first project of this particular building type you have undertaken at ASU. ASU's design philosophy does not allow for a "cookie cutter" approach to design; hence, there will be many unknowns to your team in working with ASU. Time spent in researching the project goals ASU, familiarity with campus infrastructure, how and why design was handled in a particular way on a similar project, and familiarity with the university and user group structure prior to the beginning of architectural programming, will be valuable. The Project Manager assigned the responsibility to lead this project on behalf of ASU is your single best resource for the project. **All questions and communications regarding the project, the user group or the university must be routed through the ASU Project Manager(s).** This is the established project protocol, and will be further detailed to you by those individuals. It is their responsibility to answer, or direct you to those that can answer specific questions regarding any topic connected with the project in a timely and professional manner.

2. Time Is Money

A common comment we hear from design professionals is that the project budgets, schedules and professional fee structure precludes firms from devoting the proper amount of time toward design excellence. ASU realizes that design is a time-driven undertaking, and we believe this comment can be directly attributed to poor project communications, which wastes time, money and opportunity. The project budget, schedule and your compensation will allow for both a successful design and a successful business partnership provided the following items are observed:

- Strictly observe procedures for approvals. Under no circumstance should verbal approval be accepted or given. Any inquiry or direction that potentially affects project scope, budget, schedule or your compensation should be made in writing and responded to in kind.

- Assume nothing. Assumptions made by your team without written clarification in the form of letters, meeting minutes, sketches or written telephone conference logs will promote misdirection, miscommunications, design errors and subsequently lost time. It is your responsibility to ask for and receive clarification. The worst possible assumption your team can make is assuming that a user will instantly or instinctively understand graphic or technical aspects of design without a thorough and concise explanation. Photographs and three-dimensional realistic renderings are invaluable tools to achieve this understanding.
- Direction, approvals, clarification, etc., all need to go through the assigned ASU Project Manager. Those that do not originate or go through the assigned Project Manager, no matter the level or subject, are not acceptable and are non-binding.

3. Contingencies

Many architects are under the impression that project contingencies (for design, construction and inflation) are for the use of design “extras.” This is incorrect. ASU is mandated by the Arizona Board of Regents to carry contingencies based on level of functional and construction difficulty and total project duration. Contingencies shall only be utilized to attain the critical project function and quality parameters, or “base” scope, as defined by the architectural program and schematic design.

4. Expectations

The design team is required to be within the particular design phase budget, and if the project estimate at the completion of a particular phase indicates the design is over budget, the design will not receive the necessary approval to proceed to the next phase. The team will then be required to redesign to bring the design within budget, at the design team’s expense. It is in the best interest of the design team to obtain the highest degree of detail appropriate at all phases of the design process, to account for the cost ramifications of the design intent, and avoid promotion and pursuit of design elements that can neither be justified by the program nor are affordable within the project budget.

It is the university's expectation that by following the guidelines, procedures and advice as presented in the ASU Project Guidelines, the design team will produce a facility that not only meets program, budget and schedule, but also achieves *design excellence*.

INTRODUCTION

The Purpose of the Project Guidelines

The ASU Project Guidelines apply to ASU construction projects managed by the Capital Programs Management Group and/or the University Architect's Office. Consultants are advised to refer to the sections of the Project Guidelines that relate to their specific projects and to adhere to its guidelines.

Project Guidelines Overview

The ASU Project Guidelines are an update to the document formerly known as the ASU Design Guidelines. The ASU Project Guidelines are intended to serve as a tool to assist in the planning, design and construction of ASU Facilities Development and Management projects. The Project Guidelines consist of three interrelated sections:

Section 1: Process Guidelines

The Process Guidelines identify the roles and responsibilities of the project team members, governing entities, and stakeholders; the processes and procedures at ASU; and provide a guide to common campus resources.

Section 2: Design Guidelines

The Design Guidelines assist the project team by setting expectations for design considerations. The Design Guidelines define ASU's requirements related to functionality, aesthetics, performance and sustainability.

Section 3: Technical Guidelines

The Technical Guidelines assist the project team by providing information on how ASU constructs, operates and maintains buildings and their systems. It defines performance criteria for products, materials and equipment selections as well as considerations for installation, fabrication and construction.

All questions and communications regarding the Project Guidelines shall be direct to the ASU Project Manager.

Variances to the Guidelines

Every Design Professional **MUST** provide a list of variance, using the "Project Variance Form." If there are not variances that form must be submitted with "NO VARIANCES" indicated on the form.

The Design Guidelines are the minimum requirements for design and construction at ASU. Contractors and consultants must adhere to the Guidelines in all cases, unless a written variance is obtained from ASU. The design professional must submit the "Project Variance Form" to the Project Manager who must get written approval from the CPMG Executive Director. If the Executive Director is not available the University Architect has authority to accept or reject the variance.

The **Project Variance Form** is located online at:

http://www.asu.edu/purchasing/forms/Project_Variance_Form.pdf

Updates

The Project Guidelines will be updated as requirements and procedures of ASU and the Arizona Board of Regents (ABOR) change.

SECTION 1: PROCESS GUIDELINES

ASU Office of the University Architect

The ASU Office of the University Architect (OUA) works with the ASU administration, User Group, Project Manager (PM), Design Professional (DP), and Construction Manager (CM) from project initiation and programming through preliminary design. OUA reviews the DP's work for compliance with: planning, programming, exterior and scope requirements for the project; and for conformance to required codes and ASU master plans and procedures.

Responsibilities of OUA include, but are not limited to, the following:

1. Strategic direction for University architecture and campus design.
2. Architectural programming, planning, preliminary design and project development oversight.
3. Landscape Architecture oversight and project development.
4. Capital Planning & Space Management, including space data management and reporting.
5. Classroom /Learning Environments Development and Design.
6. Campus master plans.

ASU Capital Programs Management Group

The Project Manager (PM) from the Capital Programs Management Group (CPMG) guides each project from programming through project close out and warranty. The PM works with the User Group and CMAR to review the DP's work for compliance with program requirements, schedule, budget, and for conformance to required codes and ASU standards and procedures.

The PM is the direct contact person for the Design Professional (DP), Construction Manager (CM), and other project consultants once the project has completed programming. After project programming is complete, all project work, information and correspondence is to be directed to the PM. The PM is the liaison for the user group as well as all other ASU departments. The PM is also responsible for monitoring project activities during design and construction through occupancy.

The responsibilities of the PM include, but are not limited to, the following:

1. Manages the DP and CM selection process.
2. Insures the appropriate development and conformance of the project to the program, design, budget, schedule, and ASU standards.
3. Manages all meetings between the ASU User Groups, DP and CM after project programming.
4. Recommends approval of all payments to DP and CM.
5. Evaluates DP and CM performance for preconstruction, in conjunction with ASU Purchasing.
6. In conjunction with ASU Purchasing, manages the negotiation for a GMP.

7. In conjunction with ASU Purchasing, develops the contract for construction [Design/Bid/Build, Construction Manager at Risk (CMAR), or Job Order Contractor (JOC)].
8. Manages all construction administration.
9. Manages the construction contract.
10. Manages project close-out.
11. Evaluates DP and CM performance for construction phase.
12. Manages warranty issues.

ASU Facilities Management

Facilities Management (FM) is responsible for all ASU physical facility maintenance and operational activity, and therefore has a vested interest in the maintainability and long term operational cost of every physical addition to ASU campuses. The PM attends all scheduled project meetings in both the design and construction phases, and may elect to include other FM personnel as their experience and technical expertise is required.

For all significant construction projects, a Facilities Management project representative will be required by the project manager to participate as a construction team member.

The FM project representative acts in an advisory capacity to the project, and will convey any necessary project issues or information needing resolution to the PM in the design phases and construction phase, for incorporation by the DP.

The responsibility of this individual includes, but is not limited to the following:

1. Obtains information regarding ASU infrastructure, maintenance and operation.
2. Advise on the serviceability, maintenance and quality aspects of all project components and systems.
3. Keeps FM shops and Administration informed of all project activity, issues and progress.
4. Routing of all project document submittals to the applicable FM shops for review and comment.
5. Informing and scheduling FM shops to attend meetings or reviews as necessary.
6. Attends all regularly scheduled project design and construction team meetings.

ASU User Groups

The ASU User Group (or User) are those colleges, organizations or departments that will be the actual occupants or the direct beneficiaries of the project. User groups can be comprised of several colleges, organizations or departments or a single uniform group. For every project, a User Group(s) Representative/Contact Person will be appointed in order to convey consensus opinions, concerns, comments or information to the design team.

Appropriate sign-off of the DP's drawings and specifications by the User Representative will be required at each major design phase submittal.

The User Group acts in an advisory and informational capacity to the project design team regarding programming/design function and space parameters. These parameters, and the resulting response by the DP to them, will only be discussed at the regularly scheduled meetings or will be conveyed by the User Representative to the DP through the PM or OUA team member.

ASU Permitting & Inspections

An ASU Building Permit Application is required for all construction work, including donated work. Construction work includes but is not limited to: new construction; demolition; remodels; fire alarm systems; new mechanical, electrical, plumbing and structural systems; replacement of mechanical, electrical, plumbing and structural systems with modifications; hot work; temporary power connections; manufactured housing installations; and other types of projects such as drywell installations, repairs and closures. Depending on the project scope, additional permits may be required by other state agencies. Design, materials and workmanship shall comply with current accepted codes and ASU's Design Guidelines designated in the contract.

ASU Building Permit Applications may only be initiated by Capital Programs Management Group (CPMG) or Facilities Management. Any exceptions shall be granted by the Executive Director of CPMG. ASU permitted projects shall be inspected to monitor compliance with accepted codes and standards, ASU Design Guidelines, contract documents and approved plans.

For detailed information regarding the current permitting and inspections guidelines go to: <https://cfo.asu.edu/fdm-bldg-permit-requirements>. If there are any questions regarding whether a permit is required contact 480-727-7100.

Asbestos Services

Asbestos becomes a health risk when the materials are disturbed and fibers become airborne and are inhaled. Older buildings often contain asbestos and newer buildings have a threshold amount for disturbance that ASU complies to and enforces which are the following:

- 160 square feet of building materials
- 260 linear feet of thermal system insulation
- 35 cubic feet of debris

Federal, state and county agencies regulate asbestos-related activities at ASU. Only ASU approved asbestos contractors and consultants are utilized for asbestos related work. Compliance with asbestos testing for buildings, remodeling or additions over 160 SF is necessary. Abatement and the clearance for re-occupancy is required prior to issuing an ASU building permit. **All ASU properties require an Asbestos review, regardless of the construction date or square footage being disturbed.** For reviews, including but not limited to remodeling, additions, improvements, flooring, window coverings, and suspect paint (which will also be tested for lead, if applicable) an asbestos review is required.

To make an Asbestos review request, use the **Request for Asbestos and Lead Services**: <https://fdm-apps.asu.edu/CPMG/AsbestosServices/>

Do not use asbestos containing materials in any ASU buildings. Construction may not begin without a Building Permit Application. If this Asbestos and Lead Services Request results in

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proceeding with your project (estimate, work order, p-card purchase, etc.), an ASU Building Permit Application is required by CPMG Building Construction Support Services for Plan Review. The Building Permit Application is located at <http://cfo.asu.edu/fdm-forms>. After plan review, subsequent plan review issues addressed and asbestos and/or lead clearance received, Building Construction Support Services will issue a Building Permit.

For additional information see **CPM 301-05: Abestos Abatement:**
<http://www.asu.edu/aad/manuals/cpm/cpm301-05.html>

State Fire Marshall and ASU Environmental Health & Safety

All projects must be submitted by the DP to ASU Environmental Health and Safety (EH&S) prior to review and approval by the State Fire Marshall, at the completion of each design phase. EH&S also reviews plans and projects for fuel burning equipment, lab design for equipment and equipment placement, life safety requirements, and environmental regulatory compliance.

State Historic Preservation Office

Proposed additions or rehabilitation of historic properties must be reviewed by the State Historic Preservation Office for compliance with the *Secretary of the Interior's Standards for Rehabilitation* for any work which may affect the character of an historic property. Historic properties are those which are listed on the National Register of Historic Places or may be eligible for listing. They include buildings, structures, sites, districts and/or objects.

The ASU Historic Preservation Coordinator in the Office of the University will assist design teams with compliance and will submit the proposed actions on historic properties to the State Historic Preservation Office (SHPO) for review. The PM will coordinate meetings and communication with the Historic Preservation Coordinator.

ASU University Technology Office

The University Technology Office (UTO) is responsible for all voice and data communication and transmission design for ASU. UTO reviews and assists all project design engineering regarding telecommunications and data for conformance with ASU Telecommunications Design Guidelines. Sign-off by UTO will be required prior to completion of design. The DP is responsible for submittals and incorporation of any comments received. If required, this group will advise the DP in the design phases regarding ASU telecommunications and data interfacing, serviceability and maintenance. See Part 3: Division 27 00 00, Communications.

State Elevator Inspector

Elevator shaftway and equipment contract documents must be submitted by the Contractor to, and written approval received from, the Arizona Chief Elevator Inspector, Division of Occupational Safety and Health, Industrial Commission of Arizona, 1624 North Adams Street, Phoenix, Arizona, P.O. Box 19070, Zip 85005; Telephone No. (602)255-3313.

ASU Police Department

The ASU Police Department (PD) will review the project for life safety, security and fire conflicts or inconsistencies with adopted codes, standards and ASU practices. All designs must

be reviewed and commented on by ASU PD; however, this department *should not* be viewed, nor does it function as, a code checking entity. If required, this department will advise the DP in regard to life safety, security and fire considerations.

ASU Parking & Transit Services

ASU Parking & Transit Services (PTS) is a self-supporting, service organization dedicated to balancing the competing parking needs of a large and diverse metropolitan university. Parking at ASU is at a premium. To make the system work for all parking clients, it is necessary to use a system of controls.

ASU Parking and Transit Services (PTS) must be consulted when a project affects any pedestrian and vehicular access, flow, density, direction or parking on campus, either on an interim or permanent basis. PTS shall review and sign off on the site plan and construction staging plan prior to design completion. The DP is responsible for submittals and incorporation of any comments received. If required, PTS will advise the DP regarding campus pedestrian and vehicular circulation, use patterns and construction parking.

Measures specifically dealing with construction are listed on the Parking & Transit Services website: <http://www.asu.edu/parking/pdf/construction-policy-current.pdf>,

If you have any questions, please contact the PM affiliated with your project or Parking & Transit Services at (480) 965-6803.

Coordination with Municipalities

ASU campuses and buildings are located in the cities of Tempe, Phoenix, Mesa, Glendale, Lake Havasu, Scottsdale, Payson, Chandler, etc. ASU's intention is to maintain a strong collaborative relationship with each municipality while reserving its own rights and responsibilities. Most buildings that are used and occupied by ASU sit on Arizona Board of Regents land, however many do not. There are many different ownership, maintenance, permitting, and space-use relationships in place and it is critical for design professionals and contractors to understand the status of those relationships for their project. Those questions must first be directed to the ASU Project Manager. All civil engineering drawings showing grading, drainage, curb cuts, street tie-ins, water and sewer connections, storm water drainage, etc., shall be submitted to the city where the project is located.

From time to time the goals of ASU and a partner municipality may conflict. Although outside design professionals and contractors should fully understand the project issues, they are not to negotiate with municipalities on ASU's behalf. Resolving specific project issues of that kind is the role of Capital Programs Management Group (CPMG) in concert with University Real Estate Development (URED) and others at ASU. Outside design professionals and contractors should feel free to identify potential issues and inquire with the ASU Project Manager about coordination with the applicable city.

U. S. Dept. of Agriculture and Dept. of Health & Human Services

All facilities for animals kept at the University (with the exception of rodents) are inspected regularly by these agencies. If compliance is not met, these facilities may be closed down or grants or contracts may not be extended.

Solar/Alternative Energy Process

The ASU Solar Team is responsible for coordinating the design, installation, operation and maintenance of all solar systems and alternative energy projects (SAE) on/in all ASU properties and ASU facilities. The Solar Project Manager Sr. schedules project meetings for each project site inviting various Facilities Development & Management (FDM) personnel as well as representatives from other university departments and local utilities key to the installation and operation of each system.

The ASU Solar Team is comprised of the Associate Vice President for FDM, the CPMG Director of Design & Support Services, the SAE Project Manager Sr., and the Technology Support Analyst Coordinator in Facilities Management's Fire Systems & Support Technologies (FSST) group.

All new construction and major renovations shall consider alternative energy strategies in their design. The ASU SAE project manager shall be included in the design process. Contact the ASU Solar Team for specific contact information for the following:

- Parking & Transit
- Residence Life
- City of Tempe
- City of Phoenix
- City of Mesa
- Local Utilities
 - APS (Arizona Public Service) services the Tempe, Downtown Phoenix, and West campuses.
 - SRP (Salt River Project) services the Polytechnic campus and the ASU Research.
 - The ASU Solar Team will advise for installations at other ASU locations.

Common Acronyms and Abbreviations

This section defines common acronyms and abbreviations used at ASU that might appear in the guidelines, at project meetings, etc. The acronyms are subdivided into categories.

Outside Entities

ABOR	Arizona Board of Regents
AIA	American Institute of Architects
AZBTR	Arizona Board of Technical Registration
CoP	City of Phoenix
CoT	City of Tempe
DoJ	Department of Justice
EEOC	Equal Employment Opportunity Commission
JCCR	Joint Committee on Capital Review
JRC	Joint Review Commission (ASU/City of Tempe)

SECTION 1: PROCESS GUIDELINES

Mesa	City of Mesa
NAU	Northern Arizona University
NCES	National Center for Educational Statistics
NFPA	National Fire Protection Association
OCR	Office for Civil Rights
OSHA	Occupational Safety and Health Administration
SHPO	State Historic Preservation Office
U of A	University of Arizona
USGBC	United States Green Building Council

ASU Entities

ABS	Auxiliary Business Services
ACE	Alliance for Construction Excellence
B&F	Business and Finance
BTS	Business Technology Services
CHS	Campus Health Service
CLAS	College of Liberal Arts & Sciences
CONHI	College of Nursing & Healthcare Innovation
CPMG	Capital Programs Management Group
CSPO	Consortium for Science, Policy, and Outcomes
CTI	College of Technology & Innovation
DACT	Department of Animal Care Technologies
DEWSC	Del E. Webb School of Construction (part of SSEBE)
DPC	Downtown Phoenix Campus
EH&S	Environmental Health & Safety
EOSS	Educational Outreach & Student Services
FDM	Facilities Development and Management: OUA, CPMG, and FM collectively
FM	Facilities Management
FSE	Fulton Schools of Engineering
GPSA	Graduate & Professional Student Association
HIDA	Herberger Institute for Design and the Arts
IHO	Institute of Human Origins
MLFTC	Mary Lou Fulton Teacher's College
OGC	Office of General Council
OKED	Office of Knowledge Enterprise Development
OUA	Office of the University Architect
PD	ASU Police
PTS	Parking and Transit Services
SOLS	School of Life Sciences
SDA	Sun Devil Athletics (formerly Intercollegiate Athletics)
SDF	Sun Devil Fitness
SESE	School of Earth and Space Exploration
SHESC	School of Human Evolution & Social Change
SNHP	School of Nutrition and Healthcare Promotion

SECTION 1: PROCESS GUIDELINES

SSEBE	School of Sustainable Engineering and the Built Environment
TDS	The Design School
URED	University Real Estate Development
UTO	University Technology Office
USG	Undergraduate Student Government
WPC	William P. Carey School of Business

ASU Campuses and Buildings

BA	Business Administration
BAC	Business Administration C-Wing
CHP	Combined Heat and Power Facility
DPC	Downtown Phoenix Campus
HSB	Health Services Building
ISTBx	Interdisciplinary Science and Technology Building x
NFAC	Nelson Fine Arts Center
Poly	Polytechnic Campus
RSSx	Research Support Services x
SCOB	Schwada Classroom Office Building
SHESC	School of Human Evolution & Social Change (building)
UCent	University Center (at the DPC)
USB	University Services Building
USE	Urban Systems Engineering
VDS	Vista del Sol
West	West Campus

Common Project Acronyms

AHJ	Authority Having Jurisdiction
AFF	Above Finished Floor
ASF	Assignable Square Feet
AV	Audio / Visual
BIM	Building Information Modeling
C of O	Certificate of Occupancy
CAD	Computer Aided Design
CIP	ABOR Capital Improvement Plan
CDP	ABOR Capital Development Plan
CDs	Construction Documents Phase
CM	Construction Manager
CMAR	Construction Manager at Risk
DBB	Design/Bid/Build
DD	Design Development Phase
DG	Decomposed Granite
DSI	Digital Signage Initiative
DP	Design Professionals: the team of architects and engineers
FF&E	Furniture, Fixtures, and Equipment
GMP	Guaranteed Maximum Price

SECTION 1: PROCESS GUIDELINES

GSF	Gross Square Feet
HVAC	Heating, Ventilation, and Air Conditioning
IPD	Integrated Project Delivery
ISAAC	Integrated System at ASU for Access Control
JOC	Job Order Contract
LA	Landscape Architect
LAD	Litter Abatement Device
MEP	Mechanical, Electrical, and Plumbing
OAC	Owner/Architect/Contractor
P3	Public/Private Partnership
PA	ABOR Project Approval
PEFI	Postsecondary Education Facilities Inventory
PI	Principal Investigator
PD	Project Definition
PDP	Project Definition Phase and Project Definition Package
PM	CPMG Project Manager
RFP	Request for Proposal
RFQ	Request for Qualifications
SD	Schematic Design Phase
SoQ	Statement of Qualifications
TMA	Too Many Acronyms
TPC	Total Project Cost

Common Guideline Terms

ACM	Asbestos-Containing Material
ADA	Americans with Disabilities Act
ADAAG	Americans with Disabilities Act Accessibility Guidelines
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials Standards
BAS	Building Automation Systems
CFM	Cubic Feet per Minute
GSF	Gross Square Feet
kW	Kilowatt
IBC	International Building Code
LEED	Leadership in Energy and Environmental Design
mm	Millimeters
NSF	Net Square Feet
OEM	Original Equipment Manufacturer
PSF	Pounds per Square Foot
PSI	Pounds per Square Inch
PVC	Polyvinyl Chloride
SF	Square Feet
UFC	Uniform Fire Code
UL	Underwriter's Laboratories
UPC	Uniform Plumbing Code

SECTION 2: DESIGN GUIDELINES

Sustainable Design Guidelines

The ASU Sustainable Design Guidelines complement the LEED (Leadership in Energy and Environmental Design) certification guidelines. Design Professionals and Contractors shall incorporate the guidelines into their projects, to the greatest extent possible. The ASU Office of the University Architect (OUA) and the Sustainable Design Advisory Committee (SDAC) will review all projects for compliance with the guidelines and work with the project team to maximize sustainability opportunities.

The **ASU Sustainable Design Guidelines** are located online at:

http://www.asu.edu/purchasing/forms/Sustainable_Design_Guidelines.pdf

Site Improvements Design Guidelines

Campus development is guided by four planning principles that relate to ASU's eight design aspirations for a New American University. The four planning principles are:

1. Foster change
2. Connect people
3. Embody sustainability and resiliency
4. Inspire community

In keeping with ASU's entrepreneurial spirit, landscape design must foster change to encourage innovation and help transform the campus and society. As physical places, ASU's campuses must connect people to conduct research, enable student success, and create knowledge. By embodying sustainability and resiliency, ASU can leverage its place, connect with it communities and engage both locally and globally. And as it inspires commitment, ASU can maintain the support it will need to sustain its mission.

The **ASU Site Improvements Design Guidelines** are located online at:

http://www.asu.edu/purchasing/forms/Site_Improvements_Design_Guidelines.pdf

Accessibility Standards

The ASU Accessibility Standards provide additional requirements that supplement the Americans with Disabilities Act Standards.

The **ASU Accessibility Standards** are located online at:

http://www.asu.edu/purchasing/forms/Accessibility_Standards.pdf

Classroom Design Guidelines

The Classroom Design Guidelines are overarching principles to create functional, flexible and aesthetically pleasing classrooms. The Classroom Design Guidelines also incorporate the Classroom Space Utilization Guidelines, which are a reporting and planning tool.

The **ASU Classroom Design Guide** are located online at:

http://www.asu.edu/purchasing/forms/Classroom_Design_Guide.pdf

Electrical Reliability

The ASU Electrical Reliability Standard defines categories of emergency, standby and normal electrical needed to serve the various loads at ASU.

The **ASU Electrical Reliability Guidelines** are located online at:

http://www.asu.edu/purchasing/forms/Electrical_Reliability.pdf

Signage Guidelines

The ASU Signage Guidelines are applicable to all properties owned, leased or controlled by ASU, all University departments, agencies and tenants of campus. Please contact the Office of the University Architect if you have any questions or comments regarding signage guidelines at ASU.

The intent of the environmental graphics and signage as covered in the ASU Signage Guidelines is, first and foremost, to guide visitors through the University to their destinations with safety and ease. A primary component of that intent is to provide the disabled access by providing braille, tactile, or visual signage as required by law. Careful consideration has been given to develop a guide that provides an aesthetically appropriate, as well as cost effective, solution for thousands of signs, offering versatility and expandability of those signs and the signage system as the needs of the University grow and evolve. The signage in the guidelines is designed to provide ease of integration and maintenance within various interior spaces, as well as to promote ASU's commitment to quality and sustainability in all areas of the campus environment.

The **ASU Signage Guidelines** are located online at:

http://www.asu.edu/purchasing/forms/Signage_Guidelines.pdf

Solar/Alternative Energy Design

The ASU Solar Team is responsible for coordinating the design, installation, operation and maintenance of all solar systems and alternative energy projects (SAE) on/in all ASU properties and ASU facilities. All new construction and major renovations shall consider alternative energy strategies in their design.

The **ASU Solar/Alternative Energy Design** is located online at:

http://www.asu.edu/purchasing/forms/Solar_Alternative_Energy_Design.pdf

Engineering Design Guidelines

The engineering design guidelines have been established to address the most common project elements at ASU. They are to be used in conjunction with the requirements set forth by applicable codes, laws and ordinances of this jurisdiction, recognized industry standards, good engineering practice and specific program needs. Omission of reference in these guidelines does not relieve responsibility for compliance with these requirements.

Consultants are encouraged to use professional judgment and ingenuity. The provisions of these guidelines are not intended to prohibit the use of alternative systems, methods or components.

SECTION 2: DESIGN GUIDELINES

The consultant is ultimately responsible for the final design and its performance. Due diligence shall be performed to ensure the design is equivalent or superior to the prescribed elements of the guideline. As required, the consultant shall propose modifications to the guidelines to meet specific project goals, conditions and requirements through ASU's formal variance process.

The **ASU Engineering Design Guidelines** are located online at:
http://www.asu.edu/purchasing/forms/Engineering_Guidelines.pdf

SECTION 3: TECHNICAL GUIDELINES

INTRODUCTION

Revised May 2013

These guidelines are intended to augment, not supersede, the applicable codes. Any code variances need to be approved by the AHJ in writing.

Except as otherwise noted herein, these guidelines are not specifications and are not be used as the project specifications. The Design Professional (DP) is expected to generate individual project specifications per these guidelines.

These guidelines may require modification to meet the needs of a specific project. It is up to the design professionals and their consultants to inform the Owner of important changes that they intend to implement.

Nothing in these guidelines is intended to remove ultimate professional responsibility from the design professional. In the event that the DP takes exception to some aspect of the guidelines it is the responsibility of the DP to bring this situation to the attention of the Project Manager so that the difficulty can be alleviated.

DIVISION 0 – PROCUREMENT AND CONTRACTING REQUIREMENTS

For continuity, use the following Division 0 section numbering when referencing to/from other specification sections for Division 0 specifications:

00001	Project Title Page	
00005	Certifications Page	
00007	Seals Page	
00010	Table of Contents	
00015	List of Drawings	
00020	List of Schedules	
00200	Instructions to Bidders	
00210	Supplementary Instructions to Bidders	
00220	Bid Scopes	
00250	Pre-Bid Meeting	
00300	Information Available to Bidders	
00310	Preliminary Schedules	
00320	Geotechnical Data	
00330	Existing Conditions	
00340	Environmental Assessment Information	
00350	Project Financial Information	
00360	Permit Application	
00400	Bid Forms and Supplements	
00410	Bid Forms	Bid Form - Construction Management Bid Form - Cost-Plus Fee Bid Form - Procurement Bid Form - Stipulated Sum Bid Form - Unit Price

SECTION 3: TECHNICAL GUIDELINES

00430	Bid Form Supplements	Allowance Form Alternate Form Bid Security Form Bid Submittal Checklist Estimated Quantities Form Proposed Products Form Proposed Subcontractors Form Unit Price Form Wage Rates Form Work Plan and Equipment Schedule
00450	Representatives and Certifications	Contractor's Qualifications Minority Business Enterprise Affidavit Non-Collusion Affidavit Qualification Statement for Waste Disposal Statement of Disposal Facility Workers' Compensation Certificate Schedule
00490	Bidding Addenda	
00500	Agreement	
00510	Notice of Award	
00520	Agreement Form	Agreement - Construction Management Agreement - Cos-Plus Fee Agreement - Procurement Agreement - Stipulated Sum Agreement - Unit Price
00540	Attachments to Agreement Form	Allowance Amounts Supplementary Scope Statement Unit Price Schedule
00550	Notice to Proceed	
00570	Definitions	
00600	Bonds and Certificates	

SECTION 3: TECHNICAL GUIDELINES

00610	Bonds	Consent of Surety Lien Bonds Maintenance Bonds Performance Bonds Payment Bonds Special Bonds Warranty Bonds
00620	Certificates	Acceptance Certificate Application for Payment Certificate Certificates of Insurance Certificates of Compliance Certificates of Substantial Performance and Completion Certificates of Final Performance and Completion Final Settlement Certificate
00640	Release of Liens	
00650	Statutory Declaration Forms	
00700	General Conditions	
00800	Supplementary Conditions	Anti - Pollution Measures Assigned Contracts Equal Employment Opportunity Requirements Health and Safety Criteria Insurance Requirements Labor Stabilization Agreement Letter of Assent Non - Segregated Facilities Requirements Procurement Contracts Specific Project Requirements Statutory Requirements Wage Determination Schedule Wage Rate Requirements
00890	Permits	Notices
00900	Addenda and Modifications	
00910	Addenda	
00920	Claims	

SECTION 3: TECHNICAL GUIDELINES

00930	Clarifications and Proposals	Change Order Proposals Change Order Requests Clarification Notices Minor Changes in the Work Proposal Requests Proposal Worksheet Summaries Requests for Interpretation
00940	Modifications	Amendments Architect's Supplemental Instructions Change Orders Construction Change Directives Field Order Supplemental Instructions Work Change Directives Written Amendments

DIVISION 1 - GENERAL REQUIREMENTS

For continuity, use the following Division 1 section numbering when referencing to/from other specification sections for Division 1 specifications.

01 00 00	GENERAL REQUIREMENTS
01 10 00	SUMMARY
01 11 00	Summary of Work
01 11 13	Work Covered by Contract Documents
01 11 16	Work by Owner
01 11 19	Purchase Contracts
01 12 00	Multiple Contract Summary
01 12 13	Summary of Contracts
01 12 16	Work Sequence
01 12 19	Contract Interface
01 14 00	Work Restrictions
01 14 13	Access to Site
01 14 16	Coordination with Occupants
01 14 19	Use of Site
01 18 00	Project Utility Sources
01 20 00	PRICE AND PAYMENT PROCEDURES
01 21 00	Allowances
01 21 13	Cash Allowances
01 21 16	Contingency Allowances
01 21 19	Testing and Inspecting Allowances
01 21 23	Installation Allowances
01 21 26	Product Allowances

SECTION 3: TECHNICAL GUIDELINES

01 21 29	Quantity Allowances
01 21 43	Time Allowances
01 22 00	Unit Prices
01 22 13	Unit Price Measurement
01 22 16	Unit Price Payment
01 23 00	Alternates
01 24 00	Value Analysis
01 24 13	Value Engineering
01 25 00	Substitution Procedures
01 25 13	Product Substitution Procedures
01 25 16	Execution Substitution Procedures
01 26 00	Contract Modification Procedures
01 26 13	Requests for Interpretation
01 26 19	Clarification Notices
01 26 33	Minor Changes in the Work
01 26 36	Supplemental Instructions
01 26 39	Field Orders
01 26 43	Amendments
01 26 46	Construction Change Directives
01 26 49	Work Change Directives
01 26 53	Proposal Requests
01 26 54	Proposal Worksheet Summaries
01 26 57	Change Order Requests
01 26 63	Change Orders

SECTION 3: TECHNICAL GUIDELINES

01 29 00	Payment Procedures
01 29 73	Schedule of Values
01 29 76	Progress Payment Procedures
01 29 83	Payment Procedures for Testing Laboratory Services
01 30 00	ADMINISTRATIVE REQUIREMENTS
01 31 00	Project Management and Coordination
01 31 13	Project Coordination
01 31 16	Multiple Contract Coordination
01 31 19	Project Meetings
01 31 19.13	Preconstruction Meetings
01 31 19.16	Site Mobilization Meetings
01 31 19.23	Progress Meetings
01 31 19.33	Preinstallation Meetings
01 31 23	Project Web Site
01 32 00	Construction Progress Documentation
01 32 13	Scheduling of Work
01 32 16	Construction Progress Schedule
01 32 16.13	Network Analysis Schedules
01 32 19	Submittals Schedule
01 32 23	Survey and Layout Data
01 32 26	Construction Progress Reporting
01 32 29	Periodic Work Observation
01 32 33	Photographic Documentation
01 32 43	Purchase Order Tracking

SECTION 3: TECHNICAL GUIDELINES

01 33 00	Submittal Procedures
01 33 13	Certificates
01 33 16	Design Data
01 33 19	Field Test Reporting
01 33 23	Shop Drawings, Product Data, and Samples
01 33 26	Source Quality Control Reporting
01 33 29	Sustainable Design Reporting
01 35 00	Special Procedures
01 35 13	Special Project Procedures
01 35 13.13	Special Project Procedures for Airport Facilities
01 35 13.16	Special Project Procedures for Detention Facilities
01 35 13.19	Special Project Procedures for Health care Facilities
01 35 13.43	Special Project Procedures for Contaminated Sites
01 35 16	Alteration Project Procedures
01 35 23	Owner Safety Requirements
01 35 26	Governmental Safety Requirements
01 35 29	Health, Safety, and Emergency Response Procedures
01 35 29.13	Health, Safety, and Emergency Response Procedures for Contaminated Sites
01 35 33	Infection Control Procedures
01 35 43	Environmental Procedures
01 35 43.13	Environmental Procedures for Hazardous Materials
01 35 43.16	Environmental Procedures for Toxic Materials
01 35 53	Security Procedures

SECTION 3: TECHNICAL GUIDELINES

01 35 91	Historic Treatment Procedures
01 40 00	QUALITY REQUIREMENTS
01 41 00	Regulatory Requirements
01 41 13	Codes
01 41 16	Laws
01 41 19	Rules
01 41 23	Fees
01 41 26	Permits
01 42 00	References
01 42 13	Abbreviations and Acronyms
01 42 16	Definitions
01 42 19	Reference Standards
01 43 00	Quality Assurance
01 43 13	Manufacturer Qualifications
01 43 16	Supplier Qualifications
01 43 19	Fabricator Qualifications
01 43 23	Installer Qualifications
01 43 26	Testing and Inspecting Agency Qualifications
01 43 29	Code-Required Special Inspector Qualifications
01 43 33	Manufacturer's Field Services
01 43 36	Field Samples
01 43 39	Mockups
01 45 00	Quality Control
01 45 13	Source Quality Control Procedures

SECTION 3: TECHNICAL GUIDELINES

01 45 16	Field Quality Control Procedures
01 45 16.13	Contractor Quality Control
01 45 23	Testing and Inspecting Services
01 45 26	Plant Inspection Procedures
01 45 29	Testing Laboratory Services
01 45 33	Code-Required Special Inspections and Procedures
01 50 00	TEMPORARY FACILITIES AND CONTROLS
01 51 00	Temporary Utilities
01 51 13	Temporary Electricity
01 51 16	Temporary Fire Protection
01 51 19	Temporary Fuel Oil
01 51 23	Temporary Heating, Cooling, and Ventilating
01 51 26	Temporary Lighting
01 51 29	Temporary Natural-Gas
01 51 33	Temporary Telecommunications
01 51 36	Temporary Water
01 52 00	Construction Facilities
01 52 13	Field Offices and Sheds
01 52 16	First Aid Facilities
01 52 19	Sanitary Facilities
01 53 00	Temporary Construction
01 53 13	Temporary Bridges
01 53 16	Temporary Decking
01 53 19	Temporary Overpasses

SECTION 3: TECHNICAL GUIDELINES

01 53 23	Temporary Ramps
01 53 26	Temporary Runarounds
01 54 00	Construction Aids
01 54 13	Temporary Elevators
01 54 16	Temporary Hoists
01 54 19	Temporary Cranes
01 54 23	Temporary Scaffolding and Platforms
01 54 26	Temporary Swing Staging
01 55 00	Vehicular Access and Parking
01 55 13	Temporary Access Roads
01 55 16	Haul Routes
01 55 19	Temporary Parking Areas
01 55 23	Temporary Roads
01 55 26	Traffic Control
01 55 29	Staging Areas
01 56 00	Temporary Barriers and Enclosures
01 56 13	Temporary Air Barriers
01 56 16	Temporary Dust Barriers
01 56 19	Temporary Noise Barriers
01 56 23	Temporary Barricades
01 56 26	Temporary Fencing
01 56 29	Temporary Protective Walkways
01 56 33	Temporary Security Barriers
01 56 36	Temporary Security Enclosures

SECTION 3: TECHNICAL GUIDELINES

01 56 39	Temporary Tree and Plant Protection
01 57 00	Temporary Controls
01 57 13	Temporary Erosion and Sediment Control
01 57 16	Temporary Pest Control
01 57 19	Temporary Environmental Controls
01 57 23	Temporary Storm Water Pollution Control
01 58 00	Project Identification
01 58 13	Temporary Project Signage
01 58 16	Temporary Interior Signage
01 60 00	PRODUCT REQUIREMENTS
01 61 00	Common Product Requirements
01 61 13	Software Licensing Requirements
01 62 00	Product Options
01 64 00	Owner-Furnished Products
01 65 00	Product Delivery Requirements
01 66 00	Product Storage and Handling Requirements
01 66 13	Product Storage and Handling Requirements for Hazardous Materials
01 66 16	Product Storage and Handling Requirements for Toxic Materials
01 70 00	EXECUTION AND CLOSEOUT REQUIREMENTS
01 71 00	Examination and Preparation
01 71 13	Mobilization
01 71 16	Acceptance of Conditions
01 71 23	Field Engineering
01 71 23.13	Construction Layout

SECTION 3: TECHNICAL GUIDELINES

01 71 23.16	Construction Surveying
01 71 33	Protection of Adjacent Construction
01 73 00	Execution
01 73 13	Application
01 73 16	Erection
01 73 19	Installation
01 73 23	Bracing and Anchoring
01 73 26	Existing Products
01 73 29	Cutting and Patching
01 74 00	Cleaning and Waste Management
01 74 13	Progress Cleaning
01 74 16	Site Maintenance
01 74 19	Construction Waste Management and Disposal
01 74 23	Final Cleaning
01 75 00	Starting and Adjusting
01 75 13	Checkout Procedures
01 75 16	Startup Procedures
01 76 00	Protecting Installed Construction
01 77 00	Closeout Procedures
01 77 13	Preliminary Closeout Reviews
01 77 16	Final Closeout Review
01 77 19	Closeout Requirements
01 78 00	Closeout Submittals
01 78 13	Completion and Correction List

SECTION 3: TECHNICAL GUIDELINES

01 78 19	Maintenance Contracts
01 78 23	Operation and Maintenance Data
01 78 23.13	Operation Data
01 78 23.16	Maintenance Data
01 78 23.19	Preventative Maintenance Instructions
01 78 29	Final Site Survey
01 78 33	Bonds
01 78 36	Warranties
01 78 39	Project Record Documents
01 78 43	Spare Parts
01 78 46	Extra Stock Materials
01 78 53	Sustainable Design Closeout Documentation
01 79 00	Demonstration and Training
01 80 00	PERFORMANCE REQUIREMENTS
01 81 00	Facility Performance Requirements
01 81 13	Sustainable Design Requirements
01 81 16	Facility Environmental Requirements
01 81 19	Indoor Air Quality Requirements
01 82 00	Facility Substructure Performance Requirements
01 82 13	Foundation Performance Requirements
01 82 16	Basement Construction Performance Requirements
01 83 00	Facility Shell Performance Requirements
01 83 13	Superstructure Performance Requirements
01 83 16	Exterior Enclosure Performance Requirements

SECTION 3: TECHNICAL GUIDELINES

01 83 19	Roofing Performance Requirements
01 84 00	Interiors Performance Requirements
01 84 13	Interior Construction Performance Requirements
01 84 16	Stairways Performance Requirements
01 84 19	Interior Finishes Performance Requirements
01 85 00	Conveying Equipment Performance Requirements
01 86 00	Facility Services Performance Requirements
01 86 13	Fire Suppression Performance Requirements
01 86 16	Plumbing Performance Requirements
01 86 19	HVAC Performance Requirements
01 86 23	Integrated Automation Performance Requirements
01 86 26	Electrical Performance Requirements
01 86 29	Communications Performance Requirements
01 86 33	Electronic Safety and Security Performance Requirements
01 87 00	Equipment and Furnishings Performance Requirements
01 87 13	Equipment Performance Requirements
01 87 16	Furnishings Performance Requirements
01 88 00	Other Facility Construction Performance Requirements
01 88 13	Special Construction Performance Requirements
01 88 16	Selective Construction Performance Requirements
01 89 00	Site Construction Performance Requirements
01 89 13	Site Preparation Performance Requirements
01 89 16	Site Improvements Performance Requirements
01 89 19	Site Plumbing Utilities Performance Requirements

SECTION 3: TECHNICAL GUIDELINES

01 89 23	Site HVAC Utilities Performance Requirements
01 89 26	Site Electrical Utilities Performance Requirements
01 89 29	Other Site Construction Performance Requirements
01 90 00	LIFE CYCLE ACTIVITIES
01 91 00	Commissioning
01 91 13	General Commissioning Requirements
01 91 16	Facility Substructure Commissioning
01 91 16.13	Foundation Commissioning
01 91 16.53	Basement Construction Commissioning
01 91 19	Facility Shell Commissioning
01 91 19.13	Superstructure Commissioning
01 91 19.43	Exterior Enclosure Commissioning
01 91 19.73	Roofing Commissioning
01 91 23	Interiors Commissioning
01 91 23.13	Interior Construction Commissioning
01 91 23.43	Stairways Commissioning
01 91 23.73	Interior Finishes Commissioning
01 92 00	Facility Operation
01 92 13	Facility Operation Procedures
01 93 00	Facility Maintenance
01 93 13	Facility Maintenance Procedures
01 93 16	Recycling Programs
01 94 00	Facility Decommissioning
01 94 13	Facility Decommissioning Procedures

01 14 00 - Work Restrictions

Revised May 2013

Description

The use of powder actuated devices shall be pre-approved by ASU prior to use.

DIVISION 2 - EXISTING CONDITIONS

02 40 00 - Demolition

Revised May 2013

Description

This section includes site, building and selective demolition. The AE shall accurately define the scope of the demolition effort required for the project. A demolition plan shall be created to graphically show the extent of the demolition work. The DP is to provide direction in his documents so that contractors practices during demolition reflect the latest environmental concerns and are not obtrusive to any University personnel or students

Design Standard

- A. Provisions shall be made in the documents to require that all demolition work be performed without disruption to adjacent occupied areas, Coordinate this important requirement with the Project Manager and indicate clearly on the documents demolition conditions to be observed.
- B. The demolition plan shall identify all materials/equipment, etc., which are to be reused and/or salvaged by either ASU or the contractor. Carefully coordinate this with the Project Manager.
- C. Items which are always salvaged by ASU:
 - 1. LED exit lights.
 - 2. Chalk/white boards.
 - 3. EMCS equipment.
 - 4. Meters (all kinds).
 - 5. Door hardware.
 - 6. Drinking fountains.
 - 7. Window blinds.
 - 8. Backflow preventers.
 - 9. Fire alarm devices.
 - 10. Simplex equipment.
 - 11. Lab fixtures.
 - 12. Lab equipment (hoods).
 - 13. Specimen, historic, heritage and memorial trees.
 - 14. Other Life Safety Equipment (AED's & AED Cabinets, Knox Boxes, Knox FDC's, and Fire Extinguishers & cabinets

SECTION 3: TECHNICAL GUIDELINES

- D. Items which ASU may elect to salvage. Depending on the item, ASU will determine on a case by case basis whether salvage is warranted. The following is a representative, but not conclusive, list of items in which salvage may be considered.
1. Wood/Hollow Metal doors.
 2. Electrical panels.
 3. Mechanical equipment.
 4. Ceiling diffusers.
 5. Projection screens.
 6. Mirrors.
 7. Irrigation equipment.
 8. Refrigeration equipment.
 9. Plumbing fixtures.
 10. Casework.
 11. Disconnect switches.
 12. Elevator equipment.
 13. Soap/Paper dispensers.
 14. Clocks.
 15. Access doors.
 16. Trees exception of specimen, historic, heritage and memorial trees).
 17. Electrical light fixtures.
 18. Electrical equipment.
 19. Starters.
 20. Windows.
 21. Transformers.
 22. Thermostats.
 23. Shelving.
 24. HVAC mixing boxes
- E. The ASU PM is the source of information about disposition of demolished material and/or salvaged items. Prior to finalizing the Construction Documents, the DP shall conduct a site meeting with the appropriate Capital Programs Management Group personnel and determine precisely what items are to be salvaged. The documents should then clearly identify what is to be salvaged, by whom and where it is to be delivered to or stored. It is the responsibility of the DP to have this information properly represented on his documents

SECTION 3: TECHNICAL GUIDELINES

F. The documents must note that the contractor is responsible for scheduling and overseeing associated demolition or salvage work that is to be performed by the owner.

G. SPECIAL DEMOLITION NOTES:

1. ASU "A" Tag Items. Note on Documents: All items encountered which contain an affixed Arizona State University control tag ("A" tag) require special procedures for disposal. Contractor to notify Project Manager when A tag items are encountered.
2. Contractor is to review the scope of the demolition plan with Environmental Health and Safety to ascertain the existence of any hazardous materials requiring special attention. Most laboratory equipment will require decontamination before demolition and/or removal, i.e. fume hoods, laminar flow enclosures, clean benches, biological safety cabinets, etc.
3. Fluorescent light fixture tubes and certain light fixture ballasts must be separately disposed of in accordance with applicable environmental regulations. Consequently, the removal and disposal of existing fluorescent light fixtures shall include the following:
4. All fluorescent tubes shall be removed and packaged by the Contractor in cartons supplied by the ASU Electric Shop. The number of tubes in each carton shall be clearly marked on the outside of the carton. Contractor to deliver packaged tubes to the ASU Electric Shop for disposal.
5. Fixture ballasts not clearly marked as containing "No PCB's" shall be removed by the Contractor and after short clipping all wires place them in a metal drum supplied to the jobsite by Arizona State University Environmental Health and Safety. After completion of the demolition effort, Arizona State University Environmental Health and Safety will remove the drum for disposal offsite. Apportioned disposal costs are then to be charged to the project.
6. All electrical services discontinued with the demolition effort shall be properly "tagged out."
7. Contractor to coordinate the regulatory requirements of the Maricopa County Department of Environmental Quality and to consult with Environmental Health and Safety to determine the exact requirements. All permits and fees for demolition are the responsibility of the Contractor
8. ASU has a comprehensive hazardous materials abatement program that precedes typical construction activities. It is the contractor's responsibility to be knowledgeable of abatement requirements and have a knowledgeable individual on site during demolition processes.
9. The contractor is to conduct his own due diligence in the event that they believe there are additional hazardous materials present in his work area. Work by ASU in no way relieves the contractor from responsibilities relative to the identification and proper remedial action of hazardous materials encountered at any time during the construction processes.

DIVISION 03 - CONCRETE

03 31 00 - Structural Concrete

Revised May 2013

Description

The design professional is responsible for proper design, specification, documentation, testing standards and procedures as are required by his licensure. No attempt has been made here to inform the DP of those reasonably expectable aspects of his service. Nothing herein relieves the DP of his obligation to prepare complete and competent documents.

Design Standard

SPECIAL ASU CONCRETE ITEMS

- A. Mock-ups are required for any structural concrete that is to receive a finish treatment such as a sandblasted, exposed aggregate, or bush hammered finish. Mock-ups shall not be incorporated into the final work.
- B. Minimum concrete compressive strength shall be 3000 psi.
- C. Fiberglass grip form ties shall not be allowed.
- D. Vapor retarder or moisture barrier shall be required for all below grade work.
- E. Penetrating sealers on exposed interior concrete floors shall be compatible with Waxie "Floorstar" products. Sealer or finish should be applied per the manufacturer's instructions and then cleaned and reapplied prior to final acceptance.
- F. Slabs shall be depressed (dished) 1/2" deep around all floor drains for a minimum radius of 3'-0".
- G. Sealed concrete: Prior to application of sealer, floors shall be cleaned with a "side by side" machine, wet vacuum and rinsed.

03 35 23 - Exposed Aggregate Concrete

Revised May 2013

Description

ASU has an exposed aggregate concrete standard in all areas of hardscape throughout the campus. The DP is to become knowledgeable of this requirement and to work with the appropriate ASU individuals so that the intent of this campus feature is represented in the new work. For campus wide uniformity the following guide is provided. It is still the responsibility of the DP to ensure through his final specification and detailed designs that the desired appearance and performance is achieved.

Design Standard

- A. All walks shall receive exposed aggregate borders 12" minimum wide on either side of the walk or 4" by 4" exposed aggregate curbing on both sides. Any border between 12" wide and 24" wide requires mechanical connections to the adjacent walks. Any exposed aggregate curbs used require mechanical connections to the walks.
- B. All exposed aggregate borders or exposed aggregate curbing shall be washed gravel, minimum exposed height of 1/4" and be hand seeded in concrete.
- C. The finish shall be medium retarded water washed, followed by a brushed acid washing after curing,
- D. Black color add-mix, 20 lbs. per c.y. In the event that the DP has compelling design rationale for the use of color other than listed above, they shall submit a composite sample, 1' by 1' illustrating the proposed color, to the variance committee for approval prior to the completion of the schematic design phase of the project.
- E. Steps, platforms, landings or any elevation change in the walk path in excess of 1-1/2", not sloped to meet ADA requirements, shall receive exposed aggregate strips of 12" minimum in width, one strip at the start of the change and one strip at the end to indicate the elevation change.
- F. Planters, benches, etc., that are located within the walk shall receive either the exposed aggregate border or exposed aggregate curbing.
- G. All planter beds, all changes in elevation greater than 1-1/2" adjacent to walks shall receive exposed aggregate borders or curbing.
- H. Any deviation to this standard is to be coordinated with the project manager.

03 45 00 - Architectural Precast Concrete

Revised May 2013

Description

This section applies to areas of a building that the DP may be considering for the use of precast panels, or special design features or projection from and around the building, that will be visible.

Design Standard

- A. The DP is to be responsible for all aspects of the appearance, craftsmanship and performance of pre-cast concrete panels. The designs must contain adequate information as may be necessary for initial owners approval, contractor's fabrication and erection.
- B. A review of PC elements by the Owner is required. Color, finish and scoring shall be clearly delineated either by a sample or a drawing of a scale that can be viewed across a conference room. Elevations that contain precast material or features shall be keyed to such a sample or drawing.
- C. Special Considerations:
 - 1. Documents are to require a full size panel be created and submitted for Owners approval prior to any casting of final items. The sample is to show special detailing and sealants so that the appearance is properly represented. When approved by the DP and Owner this panel will become the standard of quality by which all the remaining panels will be evaluated. Non-conforming panels are to be immediately replaced.
 - 2. The documents are to require that finished panels be accepted by the DP and Owner immediately upon installation on the structure. Any deviation from that initial quality level that subsequently is revealed is to be remedied immediately. In the example of damage caused by contractor's activities the panel will be replaced. Recast concrete panels shall be water sealed with products warranted for a minimum of five years against UV breakdown.
 - 3. The documents are to require approval of PC Panels after erection in place. Any damaged panels are to be replaced immediately at no cost to the owner.
 - 4. Any panels subsequently damaged during construction through no fault of the Owner are to be removed and replaced regardless of cost, difficulty or impact on schedule. Liquidated Damages will apply to the overall schedule irrespective of this type of replacement.
 - 5. Under no circumstances are PC panels to be repaired in an attempt to conceal blemishes or defects.

DIVISION 04 - MASONRY

04 05 15 - Masonry & Mortar

Revised May 2013

Description

It is the responsibility of the DP to properly utilize, design, specify and administer masonry work in the field so that the desired performance and quality are achieved. The DP is to properly specify and detail masonry veneers, applications, joints and fastening systems to protect against moisture infiltration, efflorescence, cracking caused by improper structural back-up materials and excessive maintenance. The DP should pay special attention to the fact that the owner's intent is to construct buildings that are permanent structures, i.e., have a useful lifetime of approximately 50 years.

Design Standard

- A. Depending on the project the DP may be required to show expertise in masonry design of buildings. If acceptable background cannot be proven the DP may be required to retain the services of a masonry design consultant and/or eliminate this material from the project.
- B. Specifying Masonry products for quality and performance is a very sensitive issue. The DP is to use all necessary resources to ensure that the materials installed in the field achieve the levels of performance required by the Owner.
- C. To assist the DP in understanding areas of Owner concern, the following items have been provided as a guide in the DP design and documentation. It is the sole responsibility of the DP to ensure that the finished documents and the administration of the construction achieve the Owners expectations.
 - 1. Mortar: Portland cement, ASTM C150, normal-Type II, low alkali. Hydrated lime. Mortar for repairs to existing structures, especially Historic Preservation projects, should match existing.
- D. The selection of brick for major buildings on any of the campuses will be carefully reviewed with the Office of the University Architect (OUA). The OUA must approve the final specified product and must approve the field sample that is erected for the purpose of demonstrating color, workmanship, etc.: all before material is laid on the actual structure. Final acceptance of the brick workmanship and color uniformity must also be approved by the OUA.
- E. Veneer back-up: 8 inch wide concrete masonry units, or structural steel studs with a 3/4 inch substrate (equal or better than "Wonderboard").
- F. Sealer: waterproofing sealer, guaranteed performance minimum 5 years from UV breakdown.
- G. Flashing: Through-wall concealed flashing at all shelf angles, lintels, ledges and other obstructions to downward flow of moisture within the wall.

04 05 15 - Masonry & Mortar

Revised May 2013

SECTION 3: TECHNICAL GUIDELINES

- H. Cap: The tops of all masonry walls shall receive a watertight cap, i.e., sheet metal or precast concrete with mechanical flashing under the bed joint, to prohibit moisture infiltration and efflorescence. No mortar Caps are to be proposed.
- I. Planters: Masonry veneer on other constructed items that are to be used as planters is acceptable provided that the veneer is completely independent of the “planter” structure itself. The planter is to perform its function independently of any contribution by the veneer. Planters are to be watertight, self-draining and constructed of permanent materials. Welded stainless steel liners are an acceptable planter material. Other systems of planter waterproofing have proven inadequate in the past. Planters above occupied spaces of any sort are not to be proposed. **THIS DESIGN CONFIGURATION HAS NEVER WORKED FOR MORE THAN A SHORT WHILE.**
- J. Weep Holes: polyethylene plastic tubing, 1/4 inch diameter x 4 inch long.
- K. Masonry Workmanship: Workmanship is dictated by local standards. In lieu of these local guidelines, ASU requires the following:
 - 1. For all new and infill masonry work adjacent to existing walls, require that a 3'-0" by 3'-0" mock up wall be constructed to ensure that both the brick and cured mortar colors are satisfactorily matched. Require a minimum of a 3 week curing time for evaluation of the mortar color.
 - 2. On new construction a similarly appropriately sized mock up should be constructed to establish the standard acceptance for all elements of the work, i.e. mortar color, flashing, coursing, pattern, control joints, accessories, tolerances, etc.
 - 3. Tolerances: Masonry work that does not conform to the following tolerances shall be repaired or replaced as directed by the DP. Tolerances are based on actual dimensions.
 - 4. External corners and other conspicuous lines and levels: +/- 1/4 inch in any 10'-0" section.
 - a. ii. Line of sealant filled movement joints (allowable deviation from specified or indicated): +/- 3/8 inch in any 10'-0" section.
 - b. Actual cross sectional dimension of columns and walls (allowable deviation from specified or indicated): - 1/4 inch, + 1/2 inch.
 - c. Adjacent unit faces in plane (allowable deviation from specified or indicated): +/- 1/8 inch.
 - d. Mortar bed joint thickness (allowable deviation from specified or indicated): -1/8 inch, +1/8 inch.
 - e. Mortar head joint thickness (allowable deviation from specified or indicated): - 1/8 inch, + 1/4 inch.
 - f. Vertical alignment of the centerline of corresponding headjoints in alternate courses when using other than stack bond (allowable deviation from specified or indicated): +/- 3/8 inch.

SECTION 3: TECHNICAL GUIDELINES

- g. Vertical alignment of the centerline of all head joints in a total wall height not to exceed 30'-0" when using other than stack bond (allowable deviation from specified or indicated): +/- one inch.
 - h. Vertical alignment of the centerline of all head joints in total wall height not to exceed 30'-0" when using stack bond: (allowable deviation from specified or indicated): +/- 1/2 inch.
- L. The type of mortar joint should be specified. Tooled joints are preferred. Raked and flush joints are discouraged. Any DP proposing raked joints must address his design solution for water infiltration and the elimination of efflorescence. That solution must be approved by the PM.
- M. The DP is to review the installation of masonry to ensure that the specified materials are being utilized and that the specified tolerances and levels of quality are being preserved. Any deviations are to be brought to the attention of the PM immediately.

04 40 00 - Cut Stone

Revised May 2013

Description

In the design of projects where the DP proposes the use of cut stone as a veneer on projects, the DP is to use the same care in design and specification should be exercised by the DP as with brick masonry and waterproofing systems. If the DP cannot prove expertise in this area of design, detailing and specification, he may be required to engage the services of a special consultant in this area and/or eliminate this material from the project.

Design Standard

- A. The following outline is provided to alert the DP to Owner concerns. It is the responsibility of the DP to properly address this material in his documents, specifications and field interpretations.
- B. Anchors: Stainless Steel and Conforming to latest edition of the IBC And the design requirements of the Structural Engineer..
- C. Native materials are encouraged (i.e. Arizona Sandstone).
- D. All cut stone is to be properly sealed and/or treated as is appropriate for its intended use.
 - 1. Sandstone used as an interior finish where it may be touched is to be thoroughly sealed with a product selected by the DP so that it no longer can absorb oils, grease and other common contaminants including cleaners. It is to be resealed upon completion of its installation in place.
 - 2. Sandstone used as an exterior material is to be weather sealed so that moisture cannot penetrate and degrade the material.
- E. A mockup of this material must be provided for review and approval. It is to be adjusted as required until the desired effect is achieved.

DIVISION 05 - METALS

05 50 00 - Metal Fabrications

Revised May 2013

Description

This section applies to all metal fabrications that will be used by the DP that have a visual aesthetic impact both interior and exterior. The DP should carefully design and detail metal fabrication so that they strictly comply to all applicable codes, are relatively easy to construct and maintain (finishes) and do not create potential hazards due to inconsistent heights, surface textures, harsh protrusions or "blend" too well with adjacent surfaces or finishes that could create a special hazard to the visually impaired and physically handicapped.

Design Standard

All items of design and detailing are to be performed with professional standards of care consistent with industry practices and all code requirements. Applicable Items may include: Rough Hardware, Ladders, Nosings, Trim, Pipe Railings, Stairs, Bollards and Architectural features. The following are particular ASU concerns that are to be addressed in the design.

- A. Welds should be smoothly ground to match surface texture of parent metal.
- B. Adjoining railing splices shall be fully concealed in runs that appear constant.
- C. At elbow bends, the design should facilitate mitered joints.
- D. The use of expansion bolts to secure railing assemblies to vertical or horizontal surfaces is not allowable.
- E. Exterior exposed metal fabrications shall have a permanent and high performance paint system applied. The DP must understand that priming and painting systems are a vital portion of the work and the University expects no rusting, bleed through or coating failures due to poorly specified products or lack of proper workmanship
- F. All painting is to be specified using products and manufacturer's recommendations based on an integrated painting system that is specifically appropriate for the material being coated.
- G. Fabricated Ladders shall be OSHA conforming
- H. All stair nosings shall have a permanently applied non-slip surface, either integral or imbedded, 2 inches wide minimum the width of the tread.
- I. At the top and bottom of stair landings, a contrasting color and texture to the normal stair treads shall be used to facilitate the blind and visually impaired.
- J. All fabrications with right angles corners that are exposed to public shall be radiused a minimum of 1/8 inch.

SECTION 3: TECHNICAL GUIDELINES

- K. Metal bollards shall be a minimum of 6 inches in diameter, round or square and be directly or sleeve set a minimum of 1/3 the exposed height below the finished adjacent surface. Bollard designs are to be specifically reviewed with the PM prior to the completion of the construction documents.
- L. Metal trim in continuous runs shall have concealed splices and be of sufficient gauge that natural distortions are not visually apparent. All exposed edges to the public shall be radiused or sharp edges eased.
- M. Exterior handrails and other steel items exposed to high traffic and the potential for abuse related wear and damage is to be made of Stainless Steel. Galvanized material may be considered where specifically approved by the Office of the University Architects (OUA).

DIVISION 06 - WOOD, PLASTICS & COMPOSITES

06 40 00 - Architectural Woodwork

Revised May 2013

Description

This section applies to architectural mill and casework. In general, the design and specification of items contained normally in this section must be considered to last the lifetime of the building. Flexibility, years of heavy use and misuse, limited maintenance, high impact, occasional overloading and initial cost effectiveness should be the criteria in the design and finish. This section does not apply to Laboratory Casework.

Design Standard

Endangered or limited tree species used as veneers or solid stock (mahogany, teak, etc.) are not allowable.

Any construction, building addition or alteration project which is financed by monies of this state or its political subdivisions shall not use endangered tropical hardwood unless an exemption is granted by the director of the department of administration. The director shall only grant an exemption if the use of endangered tropical hardwood is deemed necessary for historical restoration or to repair existing facilities and the use of any substitute material is not practical. Any lease-purchase agreement entered into by this state or its political subdivisions for construction shall specify that no endangered tropical hardwood may be used in the construction unless an exemption is granted by the director. As used in this subsection, "endangered tropical hardwood" includes ebony, lauan, mahogany, or teak hardwood.

- A. Soft species used for face veneers, tops, kick plates, bases or any other high impact or abrasion related use are not allowable.
- B. Wood thresholds are not acceptable.
- C. Millwork and Casework (AWI Quality Standards, Premium Grade UNO). The following are general criteria that the University has found acceptable. The DP is to make his own design decisions based on input from the DP and his own technical design criteria and be responsible for the outcome of the design and fabrication. Nothing herein relieves the DP from this responsibility.
 1. Case or millwork that will be specified as receiving a painted finish, should be limited to lower cost species (birch, poplar, etc.).
 2. All cabinet and millwork tops, sides, dividers, etc., shall be 3/4 inch minimum stock. Stained veneer materials shall conform to AWI custom grade, minimum thickness 1/16 inch. Architectural Woodwork Institute (AWI) publications are available at: <http://www.awinet.org/>.
 3. All cabinet and millwork tops, sides, dividers, etc., shall be 3/4 inch minimum stock.

SECTION 3: TECHNICAL GUIDELINES

4. Stained veneer materials shall conform to AWI custom grade, minimum thickness 1/16 inch. Architectural Woodwork Institute (AWI) publications are available at: <http://www.awinet.org/>.
5. Unexposed framing shall be nominal 1 x 2 hardwood, AWI custom grade.
6. Doors and drawer fronts shall be 3/4 inch minimum core stock.
7. Drawer boxes shall be 1/2 inch minimum plywood such as Baltic Birch with minimum 1/4" plywood bottoms.
8. Synthetic counter tops should be 5/8 inch minimum thickness.
9. Built-in shelving or free standing modular shelving height should not exceed 84" from finished floor (unless used in large storage areas) and be securely anchored to studs that are reinforced to accept the loading or to unit masonry walls.
10. All shelving should be designed as fully adjustable, 3/4 inch minimum thickness.
11. "Line bore and pin" to be acceptable with a minimum of 1" adjustments.
12. All millwork and accessory hardware shall comply with ANSI A156.9, minimum quality level Type 2 (institutional). Hinges, guides, slides, etc., shall utilize bearings complying with BHMA 201.
13. All cabinet hinges should be concealed and self-closing.
14. Drawer slides should allow full extension (1 inch longer than total drawer depth) and be specified as heavy duty (100 lb. minimum).
15. The use of painted particleboard as the finish for cabinets and tops is not acceptable. Particle board is allowable as core stock in low/no moisture areas when receiving a high pressure plastic laminate finish.
16. Particle board is not an acceptable material for shelving with greater than a 2' unsupported span.
17. The use of melamine or other similar low mill finishes (less than 0.020 inch) as interior cabinet lining or underside of shelving is acceptable in low to no moisture areas only.
18. Guides for plastic laminate finishing are as follows: min. 0.050 inch exposed horizontal surfaces; min. 0.028 inch exposed vertical surfaces; min. 0.020 inch cabinet linings and concealed backing.
19. The use of plastic laminate tops and splashes is not recommended for high moisture areas such as lav tops, coffee bar tops, or work surface that are repeatedly subjected to spillage, water cleaning, or subject to chemical substances.
20. All exposed cabinet hardware should be specified with a permanent, durable finish that is easily cleanable.
21. All countertop design shall accommodate the physically handicapped.

SECTION 3: TECHNICAL GUIDELINES

- 22. All millwork designed to support electrical equipment (computers, phones, clocks, etc.) shall have grommet openings allowing cords, interconnect cable, etc., to be concealed or routed internally. Grommets shall be 2-2-3/8 minimum diameter plastic, color to match adjacent finish.
- 23. Floors and walls that will be concealed by casework shall be cleaned prior to installation of the casework.
- D. All cabinet installations are to be fully sealed to the adjacent surfaces and constructed in such a manner that there is no location where insects or other types of contaminants can infiltrate behind or underneath the cabinets. Any holes such as may occur above the toe space at corners of base cabinets are to be considered during design and permanently eliminated. Base cabinets are to be sealed to the floor and walls with the appropriate mastic. Openings in cabinet backs are to be neatly fabricated and sealed so that no access to the space between the cabinet back and the wall surface is possible.
- E. In laboratory casework the DP is to ensure that his installation will not allow any laboratory liquids or water to penetrate beneath his cabinet designs. Rubber base is not a waterproofing component. This should be treated with the same degree of care as that which is used in the design of roofing systems.

DIVISION 07 - THERMAL & MOISTURE PROTECTION

07 00 00 - General Discussion

Revised May 2013

- A. Moisture and waterproofing systems are required at all University buildings.
- B. Impermeable moisture barriers are required for all below grade slabs and perimeter below grade walls.
- C. Foundation drainage systems, mechanical dewatering systems and equipment, dampproofing and/or waterproofing are required at all below grade walls.
- D. The DP is to carefully review these systems with the Project manager and the appropriate representatives of Facility Management prior to making decisions on systems to be used. These system components work with other penetration sealing devices located in other sections of the DP's specifications and should be thoroughly coordinated.
- E. Field fabricated below grade wall penetrations will not be allowed. Manufactured system components like link seals must be specified, detailed and provided.
- F. The choice of roofing systems to be incorporated into any building rests solely with the owner.
- G. The owner will use the opinions of the DP and others in making that decision.
 - 1. The DP is to use all tools available to him including the participation by a qualified roofing consultant and the roofing system's manufacturers' representatives to properly define and specify the roofing system to be installed.
 - 2. To expedite selection of a roofing or waterproofing system, the DP is to establish and conduct meeting(s) with the PM, representatives of the Facilities Management group and others recommended by the Owner.
- H. Spray applied foam roofs will not be allowed on University buildings.
- I. All areas of University Buildings that form a barrier between the interior space and the exterior are to be insulated.
- J. The DP is responsible for providing an environmentally appropriate system at these locations so that the thermal characteristics of the structure are well considered and that they function together to achieve the intended performance.

07 13 00 - Sheet Waterproofing

Revised May 2013

Description

This section applies to sheet waterproofing of building vertical and horizontal surfaces.. Proper architectural design and detailing of areas backed by sheet waterproofing is expected. This waterproofing is to be the primary barrier to moisture infiltration.

Design Standard

- A. The DP should specify a 5 year warranty on the material(s) being specified.
- B. The DP should specify that before membranes on horizontal surfaces are covered by protection course(s) or other work, test for leaks with a 2 inch depth of water maintained for 48 hours.
- C. All sheet waterproofing is to be inspected and approved by the manufacturer's representative prior to being covered by subsequent work.

07 21 00 - Insulation

Revised May 2013

Description

This section applies to all constructed building vertical and horizontal surfaces that are thermal barriers to the environment. It also addresses demising partitioning acting as acoustical barriers. ASU's goal for new projects is a substantial reduction in energy usage. The DP is solely responsible for the performance of the resulting insulated assemblies. These are to be designed and constructed as a vital component of the overall Mechanical system selected for the building. The following are areas in which the Owner has specific recommendations.

Design Standard

- A. Roofs or other exposed horizontal surfaces shall attain a minimum composite R value of 30.
- B. Exterior walls shall attain a minimum R value of 20 at the absolute minimum.
- C. Generally (unless noted otherwise), all corridor, restroom, classroom, laboratory, conference, meeting, lobby, and office walls and ceilings shall be fully sound attenuated. The STC classification of each instance is to be reviewed with the PM to ensure proper performance of the entire system.
- D. Where blanket type insulation or sound attenuation material is being utilized in open plenum areas, it should be specified as being "kraft" or foil faced and backed (depending on installation).
- E. B. Do not specify any form of insulation to be laid directly on accessible ceilings.
- F. Specify mechanical attachment for all insulation. Do not specify insulation to be adhesive applied or installed loose.

07 24 00 - Exterior Insulation & Finish Systems

Revised May 2013

Description

This section applies primarily to exterior insulating and finish systems that would be considered as the "secondary" skin treatment to a building, soffits, mechanical screen walls, infills, etc. The term "secondary" is used to indicate ASU's desire for brick masonry to be used as the "primary" skin material. A common trade name term that describes the system(s) covered under this section is "Dryvit". These proprietary materials are to be designed, detailed and specified in strict conformance with the manufacturer's recommendations. The DP should indicate all required expansion, control, and design joints on the project drawings.

Do not propose an EIFS treatment for areas that are accessible (can be touched) by the public.

Design Standard

- A. ASU will require a 5 year warranty on the system. Only those manufacturers that can comply with this warranty shall be specified.
- B. Concrete masonry units are preferred as the back-up construction, however if budget and/or design considerations deem this inappropriate, fiberglass reinforced gypsum/portland cement ("Wonder board") panels, 3/4 inch thick, over structural steel studs is an acceptable substrate.
- C. Composite panels of expanded polystyrene with a minimum composite R value of 20, shall be mechanically attached to the back-up system. Use only type "PM" mechanically attached systems.
- D. The composite finish system shall consist of synthetic elastomeric primus layer, minimum 3/8 inch thick and a elastomeric synthetic finish layer, minimum 1/16 inch thick.
- E. The composite system shall have a reinforcing component such as an imbedded fiber mesh as recommended by the manufacturer. This mesh is to eliminate the possibility of underlayment separation and system failure.

07 50 00 - Roofing Systems

Revised May 2013

Description

This section applies to roofs, but also pertains to other methods of roofing for those areas effectively acting as "roofs" (decks, overhangs, balconies, etc.). To aid in attaining both the written specification and warranties called for by ASU, the DP should provide sufficient expertise to accomplish this important part of the service or should retain an expert to assist. Roofing shall be done only by a roofer who is approved by the manufacturer whose materials are used. The roofer and manufacturer together will conduct their process so that all aspects of work necessary for the completed system to obtain the necessary bond are properly administered.

Design Standard

- A. The roof system and the building walls move independently from each other. The roofing system chosen shall accommodate this movement.
- B. The DP, Project Manager and representatives from Facilities Management shall meet at intervals during the selection and design of the roofing system so that all aspects of the selected system are completely understood by all.
- C. Roof slope at ASU Structures is to be a minimum of $\frac{1}{4}$ " per foot at the valleys. This applies ultimately to roof valleys and crickets areas. To achieve this, the general slope of roof planes will exceed this minimum requirement. The DP is required to render this slope accurately and in a technically correct manner so that building perimeter relationships and detailing may be accurately reviewed. The DP is encouraged to render his documents accurately so that the back sides of parapets are clearly and accurately shown.
- D. Water shall be directed from the center of a roofed area to the buildings perimeter where water collection is to take place. The DP will specifically avoid sloping roofs to a center collection point from which piping is routed through the interior of the building and underground to daylight. There will be no exception to this requirement.
- E. In no instance are rain drain leaders to be installed below slabs inside the perimeter of ASU buildings.
- F. Specify primary products, including roofing sheets, as produced and supplied from a single manufacturer as a part of a specific roofing system that the manufacturer will warranty.
- G. Specify that a single installer shall perform the work, and have not less than 5 years of successful experience in the installation of built-up systems (or others if a different system is designed) and that the installer be a part of a manufacturer sponsored quality control/warranty program.
- H. The DP should review the proposed roofing system early on (design development) with a considered manufacturer or installer of the system(s) for insights and suggestions that could alter the approach in mind.

SECTION 3: TECHNICAL GUIDELINES

- I. ASU requires a 20 year warranty/bond on all roofing systems. Only those manufacturers that can comply with this warranty should be specified.
- J. Plastic or fiberglass roof drains and/or guards are not acceptable. Nonferrous metal(s) shall be specified.

Protection of installed material:

- A. Membrane roofing is a finish material.
- B. The contractor is required to protect his finishes system from subsequent damage by other trades.

07 84 00 - Firestopping*Revised May 2013***DEFINITION**

Firestopping:

Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in, or construction joints between, fire rated wall and floor assemblies.

GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

Fire stop system components are extremely critical to the performance of University buildings.

The DP must design and specify technically correct firestopping systems to meet each individual condition throughout his project.

The services of a consultant may be in the best interests of the DP.

It is recommended that the DP review his proposed locations and materials with the ASU Fire Marshal and representatives of Facility Management prior to finalizing the design.

Each system is to represent the most current approved systems and components regardless of guideline suggestions made herein.

Only tested fire stop systems shall be used in specific locations as follows:

- A. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
- B. Safing slot gaps between edge of floor slabs and curtain walls.
- C. Openings between structurally separate sections of wall or floors.
- D. Gaps between the top of walls and ceilings or roof assemblies.
- E. Expansion joints in walls and floors.
- F. Openings and penetrations in fire-rated partitions or walls containing fire doors.
- G. Openings around structural members which penetrate floors or walls.

THROUGH-PENETRATION UL CLASSIFICATION SYSTEM

Fire Stopping Systems		UL Classification System		
		Construction Penetrated	Type Of Construction	System Identification
1	No Penetrating Items:	F, W, C	A, B, J, K, L	0001-0999
2	Metallic Pipes, Conduit or Tubing:	F, W, C	A, B, J, K, L	1001-1999

SECTION 3: TECHNICAL GUIDELINES

3	Nonmetallic Pipe, Conduit or Tubing:	F, W, C	A, B, J, K, L	2001-2999
4	Electric Cables:	F, W, C	A, B, J, K, L	3001-3999
5	Cable, Trays with Electric Cables:	F, W, C	A, B, J, K, L	4001-4999
6	Insulated Pipes:	F, W, C	A, B, J, K, L	5001-5999
7	Electrical Bus duct Penetrations:	F, W, C	A, B, J, K, L	6001-6999
8	Mechanical Ductwork Penetrations:	F, W, C	A, B, J, K, L	7001-7999
9	Multiple Penetrations Through Common	F, W, C	A, B, J, K, L	8000-8999
	Openings:			
Construction Penetration				
	F	Floor penetration		
	W	Wall penetration		
	C	Either floor or wall penetration		
Type of Construction				
	A-	Concrete floors equal to or less than 5-inches thick		
	B-	Concrete floors greater than 5-inches thick		
	J-	Concrete or masonry walls equal to or less than 8-inches thick		
	K-	Concrete of masonry walls greater than 8-inches thick		
	L-	Framed walls		

JOINT UL CLASSIFICATION SYSTEM

Fire-Resistant Joint Systems		UL Classification System		
		Joint System	Movement Capability	Joint Width
1	Floor-to-Floor	FF	D	0000-0999
2	Wall-to-Wall	WW	D	0000-0999
3	Floor-to-Wall:	FW	D	0000-0999
4	Head of Wall:	HW	D	0000-0999
Movement Capability				
D=Dynamic		Has movement capability	S=Static	Has no movement capability
Joint Width				
0000-0999	Less than or equal to 2”			
1000-1999	Greater than 2” Less than or equal to 6”			
2000-2999	Greater than 6” Less than or equal to 12”			

INSTALLER QUALIFICATIONS

Installers must be experienced, certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer's products per specified and code regulated performance requirements.

- A. Installation Responsibility: assign installation of through-penetration fire stop systems and fire-resistive joint systems in project to a single sole source fire stop specialty contractor.
- B. The work is to be installed by a contractor with at least one of the following qualifications:
 - Hilti Accredited Fire Stop Specialty Contractor (HAFSC)
 - 3M "Master Contractor"
 - Hilti "Certified Contractor" with current letter from manufacturer
 - 3M "Certified Contractor" with current letter from manufacturer
 - UL Approved Contractor
 - FM 4991 Approved Contractor
 - Any other qualifications must be reviewed and approved by the ASU AHJ and Fire Code Official.
- C. Installing firm must not have less than 3 years of experience with fire stop installation.
- D. Installing firm must have successfully completed not less than 3 comparable scale projects using similar systems.

SECTION 3: TECHNICAL GUIDELINES

- E. It is required that the DP and/or his consultant has the expertise necessary to identify, design and specify all aspects of the firestopping process. No attempt has been made here to create a specification

ACCEPTABLE MANUFACTURERS

Subject to compliance with through penetration fire stop systems (XHEZ), joint systems (XHBN), and perimeter fire stop systems (XHDG) listed in Volume 2 of the UL Fire Resistance Directory; provide products of the following manufacturers as identified below:

- Hilti, Inc., Tulsa, Oklahoma
800-879-8000/www.us.hilti.com
- 3M Company, St. Paul, Minnesota
800-328-1687/www.3m.com/firestop

Provide products from the above acceptable manufacturers; *no substitutions will be accepted.*

INSTALLATION

Regulatory Requirements: Install fire stop materials in accordance with UL Fire Resistance Directory or Omega Point Laboratories Directory.

FIELD QUALITY CONTROL

- A. Product Manufacturer's Field Services Duties during Installation: provide periodic destructive testing inspections to assure proper installation/application.
- B. Product Manufacturer's Duties After Installation is Complete: submit findings in writing indicating whether or not the installation of the tested system identified was installed correctly to both the general contractor and the Authority Having Jurisdiction.

07 90 00 - Sealants

Revised May 2013

Description

This section describes all requirements for sealants to prohibit the penetration of moisture or other contaminants like dust, and states the requirement to seal joints between dissimilar materials and certain specialized sealants which are ordinarily part of a “complete in place” installation by a particular trade (i.e. glazing sealants, painting) in the appropriate sections. Reliance on trades to provide appropriate caulking or notes such as “sealant as required” are not acceptable.

Design Standard

ALL INTERSECTIONS between dissimilar materials are to receive a sealant joint treatment that is appropriate for the items in consideration.

- A. Use a performance specification for required sealants. Do not specify proprietary manufacturer’s names or materials. Do not restrict vendors to a limited list.
- B. Specify primary products, as produced and supplied from a single manufacturer, which has produced that product successfully for not less than 5 years.
- C. Specify that an approved manufacturer’s installer shall perform the work, and have not less than 5 years of successful experience in the installation of caulks and sealants.
- D. Provide a submittal requirement for product compliance, color selection, and samples of sealants used in applicable unique joint conditions.
- E. Maximum allowable exterior joint width, for caulking/sealant, shall not exceed 1”.
- F. Backing Materials shall be a part of a manufacturers total system for the joint size and type indicated.

DIVISION 08 - OPENINGS

08 11 00 - Hollow Metal Doors And Frames

Revised May 2013

Description

This section applies to both interior and exterior applications. In general, hollow metal doors should be designed and specified for areas of heavy use and potential abuse. Commercial heavy duty hollow metal frames should be utilized regardless of whether the door be hollow metal, glass, or wood. Knock-down frames are not allowed without specific permission (see "I" below). Double door systems shall have a removable center mullion.

Wood doors with hollow metal frames are preferred for interior applications at the ASU at the Polytechnic campus.

The following specific design standard has been created as the model for all ASU installations. The DP is to thoroughly familiarize himself with these guidelines and is to ensure that his finished documents and the results in the field reflect these standards. The DP is ultimately responsible for preparing his documents in a manner compatible with these requirements and his standards of professional practice.

The DP is to meet with the project manager and representatives of ASU Facilities Management and the ASU Lockshop during the refinement of this section of the DP's specification.

Design Standard

- A. Doors and frames shall be specified as commercial heavy duty quality. Minimum door thickness shall be 1 3/4 inch thick. Interior doors shall comply with SDI-100, Grade II, heavy duty, minimum 18 gauge faces. Exterior doors shall comply with SDI-100 Grade III, extra heavy duty, minimum 16 gauge faces.
- B. Where doors are to be used as part of an acoustical barrier assembly, they shall be rated a minimum of STC 33.
- C. Doors used as a normal means of ingress and egress shall have either vision panels or adjacent sidelights (where allowable by fire ratings).
- D. Doors and frames shall have a spray applied system consisting of primers and paint.
- E. Frames shall have wall anchors a minimum of 16 inch o.c. per jamb.
- F. Doors shall carry a life of installation warranty from the manufacturer.
- G. Maximum door height shall not exceed 7'-0". Minimum door width shall be 3'-0".
- H. Designs calling for glazed openings in exterior steel doors shall use 1 inch insulated wire glass.

SECTION 3: TECHNICAL GUIDELINES

- I. Timely “knock down” door frames may be used at interior locations with the permission of the Project Manager, however, hollow metal door frames are required whenever door closers are required. See Wood Door Guidelines for framing requirements in those locations.
- J. Building floor planning (location and swing of doors, etc.) shall allow for wall space as may be required to comply with ADA requirements.
- K. Door frames are to be installed a minimum of 6” from adjacent walls.
- L. Double door assemblies may be provided with removable center mullions. In this instance the mullion shall be an integral portion of the locking system for the assembly.

08 11 16 - Aluminum Door And Frames*Revised May 2013***Description**

This section applies to exterior and interior applications as approved by ASU in lieu of hollow metal doors and frames. Double door systems shall have a removable center mullion. The following items are of concern to ASU. The DP is to produce acceptable documents and specifications for a total system.

Design Standard

- A. Doors shall be wide stile (minimum 5 inches) with 10 inch minimum bottom rail and 6 inch minimum top rails.
- B. Finish: Exposed surfaces color shall be clear, unless otherwise specified. Finish with an architectural class anodic coating.
- C. Construction and Design: Weathering shall be installed in the hinge stiles of pairs or single center hung doors. The lock stile of a single center hung door, active meeting stiles at a pair of butt hung, offset pivot, or center hung doors shall have an adjustable integral weatherstrip.
- D. Glazing shall be flush, including the horizontal mountings and sills and held in place with E.P.D.M. glazing gaskets on both sides. No applied stops shall be permitted except at the transom bar of center hung doors. Butt-hung and offset pivot door frames shall have doors stops at jambs and head with continuous weathering.
- E. Custom Hardware: Doors shall be hung with 3 Stanley FBB179 NRP 26D or equal butts. Pairs of doors shall have a Von Duprin KR4954 removable mullion. Doors shall be prepped for Von Duprin series 99NL rim device. Doors receiving keyed cylinders shall have an exterior trim 99NL. Doors without keyed cylinders shall have an exterior trim 99DT. Von Duprin Series 99NL rim device and trim to be furnished by Owner and installed by Contractor. Doors shall be installed with a Norton 7500 or LCN 4040 door closer (except where an existing HDCP had been installed). Threshold (where required) shall meet ADA specification. The DP shall coordinate closely with the ASU Lock Shop regarding every aspect of hardware to be used on a project.
- F. Performance Requirements: Air infiltration shall be tested in accordance with ASTM E283 and shall not exceed 0.06 CFM per square foot (0.003 m³/s-m²) of fixed area. Water infiltrations shall be tested in accordance with ASTM E331 with no water penetration at a test pressure of 6.24 P.S.F. (300 Pa).
- G. Structural performance shall be based on maximum deflection of 1/175 of the span, allowable stress with safety factor of 1.65. The system shall perform to these criteria under a wind load for the Phoenix area. The DP must ensure that the components that he is specifying conform to these criteria.

SECTION 3: TECHNICAL GUIDELINES

- H. Thresholds: Hollow backed aluminum thresholds have proven unable to withstand the high use of typical ASU doorways. These thresholds deform almost immediately upon installation sometimes by the contractor's own construction practices. The DP is to provide assurances that the types of thresholds and their installations are specified so that the threshold maintains its profile and properly performs for the expected life of the building.
- I. All thresholds will be set in a mastic system so that absolutely no water or air infiltration is possible from one side of the doorway to the other.

08 14 00 - Wood Doors

Revised May 2013

Description

This section applies to interior applications. Doors receiving painted finishes, should be limited to low cost species (birch, maple, etc.). Welded hollow metal frames should be utilized. Knock-down frames are not allowed with wood doors. Double door systems shall have a removable center mullion.

Any construction, building addition or alteration project which is financed by monies of this state or its political subdivisions shall not use endangered tropical hardwood unless an exemption is granted by the director of the department of administration. The director shall only grant an exemption if the use of endangered tropical hardwood is deemed necessary for historical restoration or to repair existing facilities and the use of any substitute material is not practical. Any lease-purchase agreement entered into by this state or its political subdivisions for construction shall specify that no endangered tropical hardwood may be used in the construction unless an exemption is granted by the director. As used in this subsection, "endangered tropical hardwood" includes ebony, lauan, mahogany, or teak hardwood

Wood doors with hollow metal frames are preferred for interior applications at ASU at the Polytechnic and West campuses.

Design Standard

- A. All doors shall be solid core flush with veneer faces, commercial heavy duty minimum grade, 1-3/4 inch thick. Minimum width to be 3'-0". Maximum height to be 7'-0".
- B. All doors should be specified from a single manufacturer.
- C. Doors shall carry a "life of installation" warranty from the manufacturer.
- D. Where doors are to be used as part of an acoustical barrier assembly, they shall be rated a minimum of STC 33.
- E. Doors receiving a stained finish shall be specified as having premium quality face veneers, minimum thickness 1/16 inch.
- F. Doors used as a normal means of ingress and egress shall have either vision panels or adjacent sidelights (where allowable by code) in metal frames.
- G. Doors and frames shall have a spray applied finish
- H. Frames shall have wall anchors a minimum of 16 inch o.c. per jamb.

08 44 00 - Curtain Walls*Revised May 2013***Description**

This section applies to exterior glazed curtain wall systems and storefronts (also used as fixed window systems). Curtain wall systems should be avoided on east and west exposures. The DP is expected to evaluate curtain wall locations as an integral part of the overall building environmental performance profile. Environmental awareness and sustainable factors should guide the DP in the use and location of these systems.

Design Standards

- A. The DP shall specify that a fabricator/erector shall have a minimum of 5 years' experience of similar size and scope in the fabrication and erection of systems specified in the project.
- B. Curtain wall systems shall utilize 1 inch, dual pane insulated glass, fully tempered at an absolute minimum.
- C. Steel or a hollow metal type system shall be specified. Aluminum alloy extrusions are not acceptable in areas that support or are directly adjacent to door openings unless internally reinforced.
- D. "Kynar 500" or equal shall be specified for painted finishes. This is a factory applied baked enamel. It is part of the manufacturer's guarantee.
- E. Locally applied painted finishes or powder coating shall not be acceptable in a manufactured "system".
- F. Powder coating or a professionally applied paint coating may be acceptable if the nature of the curtain wall and its custom fabrication is not backed by a manufacturer's warranty.
- G. Water penetration shall not occur at a test pressure of 7.00 psf when tested in accordance to ASTM E 331.
- H. Maximum air infiltration shall not exceed 0.05 cfm per gross square foot of exterior area, when tested in accordance with ASTM E 283, section 4.3.
- I. Where doors are utilized in curtain wall assemblies, at least one section of an exterior door assembly (main ingress and egress) shall have an electric automatic door opener, button activated at the swing side, interior and exterior.
- J. In areas where the interior clear height of curtain walls, storefront system or any fixed glass that will require periodic maintenance, exceed 30' (possibly an atrium) a permanent system(s) must be designed to facilitate window washing without the use of erected scaffolding or movable lifts.
- K. On buildings that exceed 3 stories or 30' from finish grade, an exterior window washing system shall be designed and permanently installed.

SECTION 3: TECHNICAL GUIDELINES

- L. The window washing accommodation aspect of the design shall be coordinated by the DP and designed with the full assistance of the Facilities Management Department group responsible for maintaining the appearance of the glazed system. The DP is to assure that FM approves the system prior to completion of the documents and specifications.

08 70 00 - Finish Hardware / Electronic Card System

Revised March 2010

Description

Hardware design and selection shall be reviewed and approved by the ASU Lock Shop.

This section applies to interior and exterior applications. Hardware is frequently a targeted item in budget "value engineering" efforts, causing a significant downgrading in quality which has proven to be directly attributable to total assembly failure in some university buildings. The use of cheaper or hard to get hardware not only compromises quality, but significantly increases maintenance. The DP should design and specify heavy duty commercial hardware for total life cycle value, and not compromise the initial selection based upon the "bottom line." The majority of hardware and parts inventory on ASU at Tempe campus is Schlage. Locks at the ASU at Polytechnic campus are manufactured by Best. Seek guidance from the appropriate individuals at ASU at the West and Downtown campuses for specific hardware requirement.

Design Standard

- A. Hardware suppliers shall be specified as having a minimum of 5 years' experience in supplying hardware for projects of similar size and scope, and shall have in his employ a certified architectural hardware consultant.
- B. Lock Shop and end user shall review and decide on lock functions.
- C. Door closures shall carry a minimum 10 year warranty from the manufacture against failure or leakage.
- D. Latchsets, locksets, hinges, panic devices, cylinders and holders shall carry a written minimum 5 year warranty from the manufacturer against failure. Hardware containing plastic parts are not acceptable.
- E. All latches shall be roller type; all doors rim latching; all double doors with removable center mullion.
- F. Mortise locks are not acceptable.
- G. All hardware shall be commercial grade and have a finish that is easy maintainable and hides finger prints, 626 (26D).
- H. All doors (interior and exterior) shall have lever action lock and latchsets (closed end), approved for use by the physically disabled.
- I. ASU at the Tempe campus supplies the final key cylinder, Medeco Biaxial cylinders. All hardware with key cylinders shall be compatible with Medeco cylinders. To be funded by the project.
- J. Doors shall have a minimum of 3 heavy duty type institutional hinges per door.
Ex: Stanley FBB179/260
- K. All exterior doors shall have thresholds, closures, weather-stripping, and mechanical hold opens and padded stops.

SECTION 3: TECHNICAL GUIDELINES

- L. At least one section of an exterior door assembly (main ingress and egress) shall have an electric automatic door opener, button activated at the swing side, interior and exterior.
- M. Kickplates are required of all doors that are subject to high traffic.
- N. Restroom Entrance Doors:
 - 1. Doors shall open outwards.
 - 2. Doors shall have a deadbolt lock for securing "out-of-order" restrooms.
 - 3. Provide push panel on inside, pull handle on outside.
 - 4. No latching bolt mechanisms shall be provided unless required by Code.
- O. The following manufacturer's and hardware type are acceptable at ASU at the Tempe Campus and is an example of the level of quality typical required by the owner: Contact Capital Programs Management Group to verify specific requirements at the various campuses
 - 1. General: Schlage Heavy Duty or equal (no plastic parts allowed);
 - 2. Door locks: cylinder type locks, Schlage Heavy Duty. Lever locks, Schlage Rhodes or equal;
 - 3. Dead bolts: heavy duty auxiliary type, Medeco D 11, Schlage B 400;
 - 4. All lever action hardware shall be Schlage "Rhodes" with cylindrical lock housing.
 - 5. Padlocks: Schlage 45101, Master 21, Medeco 50W080010;
 - 6. Panic devices, single door, narrow style: Precision, Apex series 1100, 1200, 1300, FL1100, FL1200, touch bar. Single door standard: Von Duprin 99, rim type; Von Duprin 3327, 9927. Single door narrow style: Von Duprin 33 rim type.
 - 7. Surface mounted closures: LCN, Norton 7500 Series;
 - 8. Manual flush bolts: Glynn Johnson;
 - 9. Magnetic holders: Rixson.
 - 10. No plastic parts allowed inside or out.
 - 11. Electrically controlled push pads shall be provided at all main building entrances and exits. Both hand and foot controlled pads shall be provided. Required pads and installation shall meet ANSI and ADA requirements and criteria.
- P. Prior to substantial completion, the manufacturer rep, hardware supplier and installer jointly inspect and certify that all hardware on the project is properly installed and properly operating.
- Q. Door closers shall be readjusted after the air balance is completed.
- R. Unused parts on all locks, along with installation instructions, shall be turned over to the ASU Lock Dept.
- S. Electronic Locks: Two types are used by ASU at Tempe campus as applicable to usage.

SECTION 3: TECHNICAL GUIDELINES

1. High Traffic, Proximity Type: Issac System by Henry Brothers (monitored).
 2. Low Traffic, Card Swipe Type: Locknetics.
- T. Laboratory Electronic Locks: These are a special application that will be designed in conjunction with Capital Programs Management Group and appropriate authority.
- U. Coat hooks on wall behind office doors are to be provided at ASU at the Polytechnic campus. Color to be white.

08 80 00 - Glass And Glazing

Revised May 2013

Description

This section applies primarily to exterior glazing systems and windows. Generally, the DRB has highly discouraged the use of high reflectivity coatings on glazing products as being not acceptable to the character predominantly found on Campus. This will be held true for this section.

Design Standard

- A. Dual pane, 1 inch insulated glass on all exterior windows. Sample pane(s) of color and reflectivity to be presented to the DRB at the schematic design review. Color glass which may not be available for future replacement over the lifespan of the building is discouraged.
- B. All glass to be in contact with normal pedestrian traffic to be tempered float glass to a height of 8' above floor surface adjacent to pedestrian traffic (or per code, whichever is stricter).
- C. Wire glass is aesthetically allowable where dictated by code. The DP should try to capitalize on the intricate geometric patterning in the design.
- D. Safety glass is recommended for use in railing areas, if so designed (in lieu of metal railings).
- E. Sidelights and/or door lights to be minimum 1/4" tempered float glass.
- F. Individual windows or window assemblies shall be designed to easily accommodate washing of the exterior surface.
- G. Exterior ledges of window openings (and other ledges) shall be designed to allow proper drainage away from the window assembly, 1/2 inch per foot is the minimum slope, 60° slope is preferred (to prevent bird nesting) although other designs (e.g. rounded ledges, etc.) will be considered by Capital Programs Management Group.
- H. Ventilated windows are not to be operated with crank mechanisms unless windows are in tandem, in which case heavy duty industrial crank mechanisms shall be specified.
- I. On buildings that exceed 3 stories or 40' from finish grade, an exterior window washing system shall be designed. See Section 11 24 23
- J. All window assemblies shall be fully weather-stripped and gasketed.

NOTE: All glass types shall be a local stock item (not special order) to eliminate replacement delays.

08 87 00 - Glazing Surface Films*Revised May 2013***Description**

This section applies primarily to exterior glazing surface films. Generally, field applied window films are to be avoided for new construction, however, they can be very beneficial when used on existing window applications for renovation projects.

Design Standard

The ASU desired performance criteria is:

- A. Spectrally-selective window film:
- B. Solar Properties (based on application to single-pane clear):
 - 1. Min. 60% VLT (visible light transmittance)
 - 2. b. Min. 60% TSER (total solar energy rejected)
 - 3. c. Max. 10% VLR-E (visible light reflectance: exterior)
 - 4. d. Max. 0.35 SHGC* (solar heat gain coefficient)
 - 5. Min. 1.00 luminous efficacy ratio

As a minimum, applied film must meet the following:

- A. Spectrally-selective window film preferred:
- B. Solar Properties (based on application to single-pane clear):
 - 1. Min. 30% VLT (visible light transmittance)
 - 2. Min. 45% TSER (total solar energy rejected)
 - 3. Max. 20% VLR-E (visible light reflectance: exterior)
 - 4. Max. 0.40 SHGC* (solar heat gain coefficient)

For (existing) tinted glass, or glass with a pre-existing film:

- A. Spectrally-selective window film preferred:
- B. Solar Properties (based on application to single-pane *tinted*):
 - 1. Min. 20% VLT (visible light transmittance)
 - 2. Min. 60% TSER (total solar energy rejected)
 - 3. Max. 20% VLR-E (visible light reflectance: exterior)
 - 4. Max. 0.40 SHGC* (solar heat gain coefficient)

**Reference IECC for maximum SHGC assembly rating.*

Interior vs. Exterior Application:

- A. In general, exterior application to double-pane glazing provides substantial performance increases. However, consideration must be given to both the first-cost installation and periodic replacement, particularly in difficult to access areas, whether by height (above the 3rd floor) or by ground obstructions.
- B. For application to single-pane glazing, interior application is always preferred, as performance benefits for exterior application are negligible. However, the presence of prior existing film may preclude another application, and therefore require the use of an exterior film.
- C. Exterior films must have minimum (5) year warranty. Interior films must have minimum (15) year warranty. Warranties must be sufficient to cover both the cost of the film replacement, and the glazing (including labor), in the event of thermal shock fracture. Glazing should be inspected/tested on site and approved by the PM prior to application of any film product, to ensure it is of an appropriate type and in sufficient condition to accept film, without excessive risk of fracture.

DIVISION 09 - FINISHES

09 22 16 - Non-Structural Metal Framing

Revised May 2013

Description

This section refers to light gauge metal framing and should use a “performance specification”. Do not specify proprietary manufacturer’s names or materials, and do not restrict vendors to a limited list.

Design Standard

- A. Minimum framing shall be 25 ga. galvanized metal studs on 16” centers to a maximum height of 12’. Minimum 20 gauge galvanized metal framing on 16” centers to be provided where wall heights exceed 12’.
- B. Provide full height (to structure) studs at door and window jambs.
- C. Provide diagonal stud bracing to structure at 48” on center (staggered) where partitions terminate at or slightly above the lay in acoustical ceiling grid.
- D. In areas where partitions are subject to severe impact loads, and in situations where fixtures and appurtenances are intended to be supported directly from partitions, require backing and/or blocking in the partitions. Describe the locations for all backing and blocking on the drawings. Considerations for blocking are as follows:
 - 1. Provide 20 gauge metal backing where numerous light weight fixtures are intended to be supported directly from the walls.
 - 2. Provide 3 1/2 “ tall sheet metal blocking at the bottom of heavy duty partitions where resilient floors are scheduled to be installed (to protect walls from floor cleaning equipment impacts.)
 - 3. Provide 6” high minimum wood blocking or 20 gauge metal at points of attachment for small fixtures, toilet accessories and partitions, handrails, door stops, etc.
 - 4. Provide engineering for built up headers made of lt. Ga. metal framing.
 - 5. Provide built up members at corners, jambs and other locations where stresses are enhanced.

09 26 00 - Veneer Plaster

Revised March 2010

Description

This section applies to interior areas that are subject to main traffic circulation or are subject to continual impact or heavy use.

Design Standard

- A. The design should incorporate veneer plaster over metal lath in any interior area exposed to medium to high traffic or adjacent to potential impacts (corridors, restrooms, lobbies, elevator lobbies, etc.).
- B. Specify an elastomeric based veneer plaster, application to comply with ASTM C843.
- C. Minimum 3 coat application, 1/8 inch base coat, 1/16 inch final coat, for a total thickness of 3/16 inch.
- D. Expansion joints shall be provided in accordance with manufacturers' recommendations.

09 29 00 - Gypsum Board

Revised May 2013

Description

This section addresses the installation and finish of Gypsum Board.

Design Standard

- A. All application of Gypsum Board shall adhere to “APPLICATION AND FINISHING OF GYPSUM PANEL PRODUCTS (GA-216-2004)” or “APPLICATION OF GYPSUM SHEATHING (GA-253-99)” publications of the Gypsum Association and all ASTM specification it refers to.
- B. All Gypsum Board products and finish levels shall adhere to code requirements unless noted otherwise,
- C. Provide Level 4 finish typically throughout.
- D. Walls that are to receive “Walltalker” finish and other special areas as determined by the DP shall receive Level 5 finish.
- E. No 1/2 inch thick gypsum board is to be used at ASU.
- F. All Gypsum Board shall be minimum 5/8” thick with a fire rated skin.
- G. All Gypsum Board in all areas of toilet rooms and other areas where moisture will be present in any form will be mold resistant.
- H. Related types of hard board material applied to metal studs will be selected to adequately meet the requirements of the intended use and shall be used strictly in accordance with the manufacturer’s recommendations. An example of this material is hard board cementitious-based tile backer.

09 30 00 - Tile*Revised May 2013***Description**

This section applies to interior and exterior areas using ceramic tile for floors, walls, counter tops, wraps and architectural design accents. Specify manufacturers of tile products that are widely available, have proven track records and have relatively short lead times in the production and shipping of the product.

Design Standard

- A. Ceramic tile products should be specified that can endure high impact, low water absorption rates, and have low dimensional and color variations per order.
- B. Minimum floor tile dimensions shall be 8 inch x 8 inch, matt finish (abrasive finish if exterior or lobby applied), and comply with the following requirements:
- C. Through color, 3/8 inch minimum thickness;
- D. Cove tile bases and all available additional accessory tiles shall be used in all restroom applications;
- E. Tile inserts or accents in a predominantly matt or abrasive finish field may be polished or glazed;
- F. Grout joints should not exceed 1/8 inch. On flooring, a non-white grout shall be designed and specified.
 - 1. Minimum wall tile dimensions shall be 4 inch x 4 inch x 5/16 inch (unless a mosaic design is anticipated, in which case the minimum dimensions will be 2 inch x 2 inch), and comply with the following requirements:
- G. Restrooms to be glazed, flat tile, thin-set on proper backing. Tile shall be full height on the wet wall(s) with a tile wainscot on remainder;
- H. Grout joints should not exceed 1/16 inch;
 - 1. A color of tile and grout should be chosen that is easily maintainable.
 - 2. Epoxy mortars and grouts shall be used in all exterior applications, wet locations, areas subject to heavy traffic and areas that may come into contact with solvents, chemicals or continuous immersion in water.
 - 3. Tile used on step treads shall have an abrasive finish or receive a rough finish imbed a minimum of 2 inch wide at the stair nosing, running the length of the tread.
- I. An additional 2% tile shall be provided for maintenance stock.
- J. All installations shall be per the manufacturer's recommendations of the products to be used.

SECTION 3: TECHNICAL GUIDELINES

- K. All preparatory work is to be accepted by the subsequent trade prior to beginning work of that trade.
- L. All workmen are to be properly skilled and knowledgeable in their area of work.
- M. The Contractor is to properly coordinate and plan the work so that the tile modules and DP Designs are preserved throughout the construction process.
- N. All grout is to be sealed prior to final inspections.
- O. Seal (caulk) joints per the USG and TCA where tiles intersect dissimilar backings.
- P. Fully protect all tile areas from completion until Owners acceptance of the structure or area.
- Q. Kraft paper is not considered protective in this instance.
- R. Carefully protect corners and exposed edges.

09 51 00 - Acoustical Ceilings

Revised May 2013

Description

This section applies mainly to suspended acoustical tile ceiling applications. The DP is to carefully create a composite reflected ceiling plan that accurately shows all proposed ceiling mounted items including the location of all lighting fixtures, diffusers, audio/visual equipment and sprinkler heads.. Generally, office areas should be designed to accommodate a 9'-0" ceiling height.

Design Standard

- A. 24 inch x 24 inch or 24 inch x 48 inch mineral fiber or noncombustible fiberglass panels, not less than 5/8 inch thick, with kerfed type edges.
- B. Minimum NRC factor of 0.90 to 1.00, minimum STC rating of 25 to 29, minimum reflectance 75%.
- C. Concealed spline systems are not acceptable.
- D. Specification should call for 2% additional material over actual material installed.
- E. Suspension grid to be exposed, heavy duty T type.
- F. Lighting, diffusers and sprinklers should be designed to occur in the system at regular or predetermined intervals. They are to be located in the center of ceiling tiles.
- G. Where walls run to the underside of the system, design and specify an acoustical seal/barrier where they meet.
- H. Maintain a 6" minimum clearance between the top of the grid and all other systems installed above the ceiling.
- I. If exception is taken to any item above, the DP shall clearly demonstrate to ASU a better or "or equal" alternative for consideration and approval.

09 63 40 - Stone Flooring

Revised May 2013

Description

Stone flooring must be chosen for its long wearing abilities as well as appearance. The DP must prove that his selection is appropriate and must be knowledgeable regarding cleaning and maintenance. The DP must support his design formally to the PM before including stone materials in his project.

Design Standard

- A. 48 inch x 48 inch maximum single panel size. Thick-set on a concrete substrate.
- B. 3/4 inch minimum thickness. The use of polished or honed stone as the predominant field material is not acceptable, except as a border or accent treatment.
- C. The use of soft varieties of stone and stone with soft veining or stones that are naturally porous and permeable, are not acceptable. Naturally clefted stone such as slate should also be avoided due to maintenance difficulty and the instability of the product.
- D. Stone used on step treads shall be cross grooved or receive a rough finish or imbed, a minimum of 2 inch wide at the stair nosing, running the length of the tread.
- E. Additional panels shall be provided for maintenance stock.
 - 1. Provide two 48 inch by 48 inch spare panels, or;
 - 2. Provide 4 tiles on other panels smaller than 48 inch.
- F. All stone flooring as well as all grout joints are to be sealed and waxed as a part of the construction process. The DP is to confer with the Project Manager and the University Janitorial Services Group to determine the correct materials to be used in this final preparation before turning the facility over to the owner.

09 65 00 - Resilient Flooring

Revised May 2013

Description

This section includes vinyl composition tile (VCT), rubberized flooring tile and rubber base.

Design Standard

- A. 12 inch x 12 inch x 1/8 inch single tile size, composition 1, asbestos free, heavy duty commercial. Linoleum sheet goods are not acceptable.
- B. VCT critical radiant flux not less than 0.45 watts per sq. cm.; flame spread not more than 75 per ASTM E 84; smoke developed not more than 450 per ASTM E 84; smoke density not more than 450 per ASTM E 662.
- C. A color should be specified that is easily maintainable. Whites and uniform solid colors are to be avoided.
- D. Floor preparation is to be done by the tile subcontractor and is to reflect the manufacturer's recommendations.
- E. Specify 4 inch x 1/8 inch coved rubber bases, dark in color with matte finish.
- F. Specify pre-formed inside and exterior corners only. Field fabrication is not acceptable.
- G. Exposed edges of resilient flooring to have butt type extruded aluminum edge strips.
- H. Specification should call for 1 box per 50 or any fraction thereof additional material for each color, pattern or type used.
- I. Specify that the contractor is to finish the VCT prior to final inspection.
 - 1. Strip the new tile surface per the manufacturer's recommendations.
 - 2. Apply at least two coats of wax per the manufacturer's instructions. This wax is to be power buffed and is not to be a liquid applied no buffing non-wax coating.
 - 3. Final waxing shall be per the manufacturer's recommendations and the products and practices of the ASU Facilities Maintenance department.
 - 4. The DP must verify these products and practices and insert these instructions into the project specifications.
 - 5. In the event that the waxing reveals defects or contaminants underneath the tile the tile is to be removed and the defect corrected. All the above cleaning and polishing steps must be applied to the replaced area until it appears identical to the remainder of the floor.

09 68 00 - Carpet And Carpet Tile

Revised May 2013

Description

ASU procures carpet materials directly using a state wide purchasing contract. All carpet goods and services are to be procured using this procedure. The ASU carpet goods buyer will assist the DP in understanding the types of materials and products that are available and will ultimately purchase and have the material installed. The DP is to coordinate the particular requirements of his project with the Project Manager and Carpet Buyer so that the process is correctly administered. There will be no exception to this requirement. The DP will indicate in his documents that the Contractor is to be aware of and is to coordinate all activities of this Owner provided item. He is to provide overall coordination and ultimately be responsible for the maintenance of his overall construction schedule. To do this the DP and Contractor will need to work carefully with the Owner throughout the process.

DP is to propose carpet in appropriate areas of his project. Carpet should be avoided in high traffic areas (main lobbies, main corridors) or area(s) prone to chemical, food, printing or reproductive media (copy rooms) or water prone areas.

ASU at the Polytechnic campus and the West campus require the use of carpet squares; no rolled goods are to be specified unless conditions require its use.

Design Standard

- A. Seek guidance from the appropriate ASU group regarding specific carpet products to be used for a specific project.
- B. Specify extruded or molded rubber carpet edge guards and/or transitions at flooring material transitions.
- C. A color and pattern should be specified that is easily maintainable.
- D. 4 inch x 1/8 inch coved rubber bases, dark in color, matte finish with preformed inside and outside corners is required
- E. Ten (10) year written warranty.
- F. Specify that carpet shall not be installed until other work (drywall installation, painting, etc.) is completed.

09 69 00 - Access Flooring

Revised May 2013

Description

The decision to utilize an access floor system is usually a strict program requirement. The DP must prove his capability to design and specify this technology accessory or he is to retain the services of an access floor consultant who is independent and not affiliated with any one manufacturer. The DP must understand the customer's needs and the ability of the different systems to accommodate them. Use of this type of system requires extremely careful coordination between the disciplines; mechanical, electrical, IT as well as others. Verify with Users whether or not an existing system is currently in place. If so make all efforts necessary to ensure compatibility with existing systems.

Design Standard

- A. Design appropriate structural capacity. Floor panels specified to comply with a uniformed live load of 250 lbs per sq. ft.; concentrated load of 1000 lbs. anywhere on a 1 inch square; deflection not to exceed 0.080 inch, permanent set not to exceed 0.10 inch.
- B. Verify the system's lateral stability. Pedestals capable of resisting a 5000 lb. axial load per pedestal and resistance to horizontal force of 20 lbs. applied to the top of the pedestal in any direction.
- C. Verify the desired electrical conductivity of the system. Not more than 10 ohms resistance between panel and under structure. Verify requirement for grounding of the system. Access systems may require electrical grounding, verify.
- D. Many different types of panel construction are available. Each has differing characteristics. ASU has experience with Panels that are 24 inch x 24 inch, steel covered wood core panels, fabricated with 1 inch thick high density particle board, top and bottom faces to be zinc coated steel. It is recommended that the DP, Project Manager, and the customer all review an existing installation of the recommended system.
- E. Pedestals shall be heavy duty, column assembly, stringerless type with vibration proof mechanisms.
- F. Areas receiving a raised or pedestal floor system shall have area floor drains at the structural floor slab. The DP and his consultants are all to address the possibility for water infiltration below the access floor system and must consider this eventuality in their designs for the under floor area.
- G. Spaces below access floor systems are subject to the requirements of the Fire Marshal. Properly coordinate any such concerns during schematic design and refine these aspects of the system through the completion of the construction documents.
- H. Carpet and tile finishes that are applied to an access floor system may be provided and installed under the ASU state purchasing agreements. DP and PM are to coordinate this aspect of the project early in schematic design.

09 72 00 - Wall Coverings

Revised May 2013

Description

Application of Wall Coverings is discouraged because of difficulties in maintainability and repair when damaged, as well as fire protection/safety concerns.

09 91 00 - Paint

Revised May 2013

Description

This section applies to exterior and interior areas or surfaces that are to receive a painted final finish. Large areas of painted exterior surfaces exposed to view and sun light should be avoided due to the annual or biannual cost of maintenance. Paint products scheduled for exterior application must be evaluated for colorfastness. Painted exterior features exposed to view that are generally inaccessible without special scaffolding or working platforms should also be avoided.

The DP is to confer with the Project Manager and the Facilities Management Paint specialists regarding University wide standards of materials, systems and colors. ASU appreciates a degree of standardization of paint colors due to the huge extent of painted surfaces and our commitment to maintenance. The DP must understand that proposing a host of special colors for this project is not a long term solution.

No attempt is made here to list or enumerate aspects of painting that should be thoroughly understood and present in the work of the DP. The following are specific considerations regarding painting that ASU would like the DP to take into consideration when specifying his painting systems and products.

Design Standard

- A. All painting materials are to be selected from the product lines of one manufacturer unless special conditions require another manufacturer.
 - 1. Each specific coating is to be comprised of an integrated system of preparation, primers and finish coats.
 - 2. The manufacturer's specifications will govern how the materials are applied, in what sequence and any other special considerations that are to be adhered to.
 - 3. A paint schedule listing colors, locations and types shall be included in the construction bid set, either as part of the finish schedule or as part of the paint specification.
 - 4. Temperature requirements for optimal paint coating system performance will be strictly adhered to.

Quality Assurance

- A. Primers and other undercoat paint shall be supplied by the same manufacturer of the finish coats. Shop primed items are to either be certified as receiving the primer necessary for compatibility with the paint system to be used or the items are to have the proper primer applied before the application of other system components.

SECTION 3: TECHNICAL GUIDELINES

- B. All paint materials (whether primers, thinners or finish) must be a manufacturers, best grade product(s), with the manufacturer's product literature identifying the material or product as such.
- C. Primers, back-primers, undercoats and finish coats must be designed and specified as a total assembly, adhering to all manufacturer's directions and recommendations. Material types must be chosen considering the surface nature to be covered, location of the surface, and the environmental conditions the surface and materials will be in continual and occasional contact with.
- D. The use of “recycled” paint is encouraged, but is not mandated.

Application

- A. Recommended application techniques:
 - 1. Metal: Spray applied.
 - 2. Walls: Spray or rolled applied.
 - 3. Floors: Spray or rolled applied.
 - 4. Doors and jambs: Spray or Brush applied.
 - 5. Millwork/Casework (prominent): Spray applied.
- B. Finishes
 - 1. Avoid the use of flat paint. Refer to the current IBC for finish standards.
 - 2. High gloss finishes are not acceptable in areas where reflective glare may be a concern (areas that contain computer terminals) or on surfaces that are in continual human contact.
 - 3. Acceptable finishes for most areas, surfaces or features are velvet flat, eggshell, satin, and semi-gloss.
- C. Exterior exposed metal fabrications shall have a spray applied epoxy-polymide type primer (as described in 05 50 00), finish paint coat(s) shall also be spray applied – Kynar or equal. A color should be chosen that does not easily fade when exposed to sunlight, and consideration given to the “faded” color.
- D. Interior exposed metal fabrications shall have spray applied epoxy-polymide type primer paint (as described in 05 50 00) and spray applied finish paint- epoxy based and/or electrostatically applied. A color should be chosen that does not easily fade when exposed to sunlight and hides hand prints.
- E. Where metal stair risers are exposed (not covered), they shall have spray-applied epoxy-polymide type primer paint (as described in 05 50 00) and spray applied finish paint-epoxy based and/or electrostatically applied. A color should be chosen that does not easily fade when exposed to sunlight and hides shoe scuff marks.
- F. At the top and bottom of stair landings, a contrasting color and texture to the normal stair treads shall be used to facilitate the visually impaired.

Quality Assurance

- A. All painted surfaces shall have consistent color and sheen throughout any continuous, flat (planar) areas.
- B. Any touch-ups or repainting required for punch lists needs to be indistinguishable. This most often will necessitate painting whole sections of a given surface where the finish can be squared off at a corner or other break in the surface.
- C. All finished surfaces shall comply with PDCA Industry Standards. PDCA standard are available at: <http://www.pdca.org/>
- D. Exterior metal stairs featuring stair treads and landings that are steel fabrications into which concrete is to be poured must receive special treatment by the DP. The interior of the steel items must be treated before the placement of the concrete so that water cannot come into contact with the steel items. The shop applied primer is not a waterproof coating and will not inhibit rust. Additionally the concrete should be tooled resulting in a perimeter joint that will receive a bead of sealant. The concrete itself should be treated with a waterproofing coating.
- E. Repair of paint coating system damaged by construction activities, field welding etc.: The contractor is to repair and reapply the full paint coating system to areas that are damaged or altered during construction. The area in question is to be cleaned and repaired/primed to that the damage is not noticeable. Then the required finish application is to be reapplied. All repair activities are to be in accordance with the original systems specification and manufacturer's instructions. Small areas shall be treated but the finish shall be reapplied to the entire surface in which the small area is located. Small spot finished areas are not acceptable. The contractor will revisit the painted areas during the 12 month walk through. Any areas that exhibit discoloration or non-uniform aging will be repainted without cost to the owner.

09 96 23 - Graffiti-Resistant Coatings

Revised May 2013

Description

Application of graffiti-resistant coatings is discouraged because of potential difficulties in future maintenance, however, it is recognized that in some installances a clear anti-graffiti coating may be necessary to provide protection of certain exterior façade materials, such as stone.

Design Standard

- A. Graffiti-resistant coating shall be permanent and shall not require re-application upon removal of graffiti.
- B. Graffiti-resistant coating shall leave the finished surfaces uniform in appearance and not alter the natural color and texture of the material to which it is applied.
- C. The DP shall submit a sample of the graffiti-resistant coating applied to the intended substrate material at the final schematic design submittal.
- D. The use of this type of coating is to be carefully reviewed by the DP, PM and Facilities Management Department. The coating must be approved by both the DP and FM prior to inclusion into the construction documents.

09 97 00 - Special Coatings

Revised May 2013

Description

This section defines special coatings as elastomeric paint on all exterior stucco or plaster work. Work under this section would consist of application of high build, acrylic maintenance coating designed to bridge cracks, facilitate water vapor passage through the assembly, prohibit water penetration, remain watertight, flexible, and colorfast for longer than normal paint applications.

Design Standard

- A. The DP shall submit a sample of color and texture of the proposed product at the final schematic design submittal.
- B. All elastomeric coatings shall be specified as requiring a 5 year guarantee.
- C. Elastomeric coatings shall be specified for any area of exterior stucco or Portland cement plaster, whether new or existing.

DIVISION 10 - SPECIALTIES

10 11 00 - Visual Display Boards

Revised March 2010

This standard for visual display boards does not include classrooms, teaching halls, or auditoriums where teaching will occur. For classrooms standards, see the *Classroom Design Guidelines*, provided by the Office of the University Architect (OUA).

Viewing Guidelines

- A. In order for the most distant viewer to read characters and symbols, the viewer should not be more than 8 times the image height from the screen.
- B. In rooms where increased visual impact is desired, the viewer should not be more than 6 times the image height from the screen.
- C. The minimum distance to the first row of seats should be 2.5 times the image height from the screen.
- D. The maximum viewing angle for viewing should be 40 degrees when measured from the opposite edge of the image.

Description

This section applies to dry markerboards, and natural cork tackboards. See *Classroom Design Guidelines*, provided by OUA, for information pertaining to visual display boards in teaching areas.

All vertical writing surfaces shall have a continuous tray at the base for markers and erasers. They shall also have a top 1 inch cork strip. Four sets of markers shall be included with every 8'-0" of marker board. Two erasers shall be included with every 8'-0" of marker board. Four map clips shall be included with every 8'-0" of marker board.

Design Standard

- A. Specify a 50 year replacement warranty for porcelain boards covering boards that do not retain their original writing and erasing qualities, become slick and shiny, or exhibit crazing, cracking, or flaking.
- B. Chalkboards shall be :
 - 1. Vitreous porcelain boards, a face sheet of 24 gauge enameling grade steel, with a 3 coat porcelainize process, writing coat greater or equal to 0.0025 inch.
 - 2. The core material shall be a minimum 3/8 inch thick industrial grade particle board, complying with ANSI A208.1, Grade 1-M-1.
 - 3. Backing sheet shall be 0.015 inch aluminum. Laminating adhesive shall consist of moisture resistant thermoplastic adhesive.

SECTION 3: TECHNICAL GUIDELINES

4. Color of finished face shall be green or black, non-glare, reflectance less than 20% and greater than 15%.
- C. Fabricated frames and trim shall be clear anodized aluminum, not less than 0.062 inches. Marker trays shall be aluminum, solid extrusion with a ribbed section, with smoothly curved ends.
- D. Dry marker boards shall be:
 1. Porcelain boards, a face sheet of 24 gauge enameling grade steel, with a 3 coat porcelainize process, writing coat greater or equal to 0.0025 inch.
 2. The core material shall be a minimum 3/8 inch thick industrial grade particle board, complying with ANSI A208.1, Grade 1-M-1.
 3. Backing sheet shall be 0.015 inch aluminum. Laminating adhesive shall consist of moisture resistant thermoplastic adhesive.
 4. Color of finished face shall be white, non-glare matte type finish.
- E. Cork tack boards shall have a single layer, 1/4 inch thick, seamless, compressed fine-grain natural cork sheet, sanded for a natural finish, complying with MS MIL-C-15116, Type II.
- F. The minimum vertical writing surface area per room should never be less than 64 sf. and typically should be 80 sf.

10 14 00 - Signage And Wayfinding

Revised May 2013

Description

This section applies to all interior and exterior spaces of buildings and common spaces that require directional signage, room numbering and identification, information plaques, etc. This section does not include signage that can be termed code-required or "emergency" type signage (fire exits, emergency labeling or direction, etc.). The types of signage and graphic standards that will be applicable to all ASU projects are defined by the ASU Signage Guidelines. Outlined below is the appropriate procedure for implementation of interior and exterior signage.

Design Standard

- A. All interior and exterior signage shall conform to the requirements as set forth by the ASU Signage Guidelines, ASU Office of the University Architect and the ASU Communication Guide. Contact the Office of the University Architect to obtain the ASU Signage Guidelines.
- B. The DP shall follow the ASU Signage Guidelines and confer with the Office of the University Architect for individual project specifications and developing new sign types.
- C. The DP in conjunction with Capital Programs Management Group and the Office of the University Architect shall determine the appropriate room numbering of all interior space prior to final schematic design. No other room numbers shall appear on the plans other than those approved by Capital Programs Management Group.
- D. The DP and/or the CM shall carry an allowance amount as directed by Capital Programs Management Group (including project, code required, wayfinding and University standard sign types), in their estimates, and identify this money as a separate construction line item, from the architectural program onward.
- E. The DP shall provide a sign program referencing sign types as identified by the ASU Signage Guidelines to determine the applicable signage types, amounts and location to be reviewed and approved by the Office of the University Architect no later than the construction document phase, for the purposes of bidding with general construction.
- F. The DP in conjunction with Capital Programs Management Group and Office of the University Architect shall ensure that ADA requirements for signs and wheelchair maneuverability are met. Building floor planning (location and swing of doors, wall intersections, fixed furniture placement, etc.) shall allow for wall space as may be required to comply with ADA requirements. Wall surfaces shall be kept clear of objects (entry card readers, side lights, fixed furniture, etc.) blocking placement of ADA required signage.

10 21 13 - Toilet Compartments*Revised May 2013***Description**

This section applies to restroom partitions and screens, but also generally applies to the space itself. Restroom toilet partitions and screens must be designed, specified and detailed heavy institutional use. The DP should carefully consider design concepts that facilitate easy maintenance, safety, complete accessibility to the handicapped, and extreme durability. Wall and ceiling construction appropriate to support the specified components is an extremely important aspect of designing for these items. Solid white partitions are not to be specified in ASU facilities.

Design Standard

- A. All partitions and screens shall be galvanized steel sheets with 2 coats of thermo setting enamel finish applied by an electrostatic process and baked (Santana products or equal). Color should facilitate easy maintenance and be a gloss finish. Gauges to be as follows:
 - 1. Overhead braced pilasters, 20 gauge;
 - 2. Unbraced pilasters, 16 gauge;
 - 3. Panels and screens, 20 gauge;
 - 4. Doors, 20 gauge;
 - 5. Concealed anchorage reinforcement, minimum 12 gauge;
 - 6. Concealed tapping reinforcement, minimum 14 gauge;
 - 7. Core material sound deadening honey comb; minimum 1 inch thick for doors, panels and screens; 1 1/4 inch minimum for pilasters;
 - 8. Pilaster shoes (at ceiling) stainless steel, not less than 3 inch high, 20 gauge;
 - 9. Hardware and accessories commercial heavy duty, chromium plated;
 - 10. Anchors and fasteners, stainless steel or chromium plated steel (to match hardware).
- B. Partitions in all new construction are to be ceiling mounted and wall secured.**
- C. All accessories shall be chromium plated finished.
- D. Handicapped stalls shall conform in all ways to current ADA requirements.
- E. Ordinary toilet stalls shall have minimum 24 inch clear door opening width(s).
- F. Individual screening of urinals in gang arrangement is generally not acceptable. The DP may propose an anchoring system for consideration by the PM but these are subject to high abuse and vandalism. It is urged that the DP give considerable thought to his design in this area.
- G. A single screen adjacent to a lav arrangement is acceptable.
- H. Restroom design should incorporate a low built-in shelf (48 inch) to place books, etc.
- I. Restroom design should hide direct lines of sight into the room without the use of a two door type vestibule, one door to the room is preferable.

SECTION 3: TECHNICAL GUIDELINES

- J. Minimum one floor drain per restroom.
- K. See section 10 28 13 for toilet accessories.

10 22 26 - Operable Partitions

Revised May 2013

Description

This section applies to operable partitions used to functional and acoustically demise large areas of general use space. The type of partitions that apply specifically are those that consist of floor to ceiling stackable panels on a track system, but may apply acoustically to accordion type partitions.

Design Standard

- A. Minimum STC composite rating of 50, tested on 100 sf. opening.
- B. Minimum in field performance equal or better than ASTM E336.
- C. Installed track deflection under full load no greater than 1/360.
- D. Minimum panel thickness shall be 4 inch, panel skins rated Class A, in full perimeter protective steel frame.
- E. Vertical sound seals between panels will be tongue and groove, consisting of steel astragals incorporating vinyl acoustical seals.
- F. Horizontal top seals shall be twin-finger continuous contact type. Mechanical bottom seals shall be made of formed steel, incorporating 1/4 inch vinyl strips for proper acoustical seal when activated.
- G. Hinges on panels and inset pass doors are recessed and project no more than 1/4 inch beyond panel face.
- H. Footbolts and stabilizers shall be internal and edge activated. No protruding footbolts attached to panel faces are allowed.
- I. Suspension system shall consist of a steel track connected to structural support by threaded rods. Each panel of a paired assembly shall be supported by one carrier assembly consisting of steel ball bearing wheels. Each panel of an individual panel assembly shall be supported by two carrier assemblies consisting of steel ball bearing wheels.
- J. Plenum closure is required for maximum sound control of the partition and must permit lifting out of header panels to adjust track height.
- K. The selection of the design should include the ease of replacement of the partition finish surface. National fabricators with local offices are best suited to address these criteria.
- L. The unit must have a two year workmanship warranty and a ten year material warranty.

10 26 13 - Corner Guards

Revised March 2010

Description

This section applies generally to the need and location of corner guards. Guards should be considered in all areas subject to heavy traffic and potential impacts (e.g. areas that have catering/food service function), and designed in such a manner that does not give the aesthetic appearance of a "tack on" or a design oversight.

Design Standard

- A. Surface mounted, clear polyester or metal; minimum 2-1/2 inch x 2-1/2 inch x 48 inch.
- B. Apply to exposed-to-view 90 degree outside corners of walls and columns.
- C. Finish may be compatible with adjacent finishes, but must be durable and highly resistant to scratches, nicks, gouges, etc.
- D. Corner guards are to be easily removable and reinstalled/replaced using common tools.

10 28 13 - Toilet Accessories*Revised May 2013***Description**

This section includes toilet accessories that are typical to the majority of projects on ASU Campuses, and does not include special or unusual items that may be applicable on specific projects. The DP will require the contractor to provide three specific items that are listed below. These are tied to the University Janitorial/Cleaning Contract.

THE DP is to review this accessory list with the proper representative of Facilities Management Administration to ensure that the list is current. For other items, manufacturers, models and types are listed both as a quality and functional standard. The DP, in design and specifying of toilet accessories, may elect to use other manufacturers, however the features and quality will have to be the same as those listed.

Design Standard

- A. All accessories shall be stainless steel with polished No. 4 finish or nickel chromium electro-deposited on base metal, conforming to ASTM B 456, Type SC 2, satin finish.
- B. Sanitary napkin dispensers: wall mounted, Rochester Midland, J6 with a minimum 25-cent coin mechanism. Equipped with a coin box lock and door lock with locking bar.
- C. Sanitary napkin disposal unit: panel surface mounted; stainless steel with bottom dump. One per toilet compartment.
- D. Coat hooks: one per toilet compartment with rubber end shock absorber.
- E. Grab bars: at handicapped compartments; 1-1/2 inch diameter, knurled stainless steel finish.
- F. Mirrors:
 - 1. One mirror per lavatory, wall mounted, 18 inch x 24 inch; one full length mirror per restroom;
 - 2. Each conforming to FS DD-G-451, Type I, Class 1, Quality q2, 1/4 inch thick, with silver coating, copper protective coating, and nonmetallic paint coating.
 - 3. All mirrors must have a moisture sealant applied to all edges.
- G. Specific items to be provided as specified: (These items may be purchased from the ASU Cleaning Service Provider directly).
 - 1. Toilet Paper Dispenser: SCA 56T1 Twin Jumbo JRT BLK -_Brady Item Code PJ0056.
 - 2. Paper Towel Dispenser: KC Sanitouch 09996 Towel Dispenser Smoke – Brady Item Code – PH9996
 - 3. Soap Dispenser: Dial Complete Foaming Soap Dispenser – Smoke or TC Manual Foam Dispenser – Blk.

10 44 00 - Fire Extinguishers

Revised March 2010

Design Standard

- A. All labs or any other area that may be considered high hazard requires a fire extinguisher cabinet (s) with an extinguisher(s) meeting the minimum rating of 2-A:20-B:C. The extinguishing agent must be ammonium phosphate. Areas with flammable metal hazards require a class "D" fire extinguisher. Travel distance to a fire extinguisher in these areas is not to exceed 50 feet. Carbon dioxide or halon agents are not acceptable.
- B. Mechanical rooms, electrical rooms and commercial kitchens will need a fire extinguisher cabinet(s) with an extinguisher(s) meeting the minimum rating of 20-B:C rating. The extinguishing agent must be of sodium bicarbonate base or of a potassium bicarbonate base. Carbon dioxide or halon agents are not acceptable. Travel distance to a fire extinguisher cannot exceed 50 feet. Fire extinguishers outside the room/area of protection cannot be included in the travel distance requirements.
- C. Corridors and all other areas requiring fire extinguishers that are not categorized in areas mentioned above or are considered light hazard to ordinary hazard areas will require a fire extinguisher cabinet and an extinguisher with a minimum rating of 4-A:20-B:C. Extinguishing agent must be ammonium phosphate. Travel distance to a fire extinguisher must not exceed 75 feet.
- D. All fire extinguishers must be UL approved and bear an individual identification on the fire extinguisher.
- E. The cylinder head and internal parts must be constructed of steel or aluminum. Stainless steel cylinders or any other cylinders requiring normal hydrostatic testing less than every twelve years are not acceptable.
- F. The manufacturer of the fire extinguisher must be one of the following: Amerex, Ansul, Buckeye, General, Kidde, or any manufacturer that can meet all requirements in this section and can be serviced with the equipment, adapters, and parts that ASU Environmental Health and Safety currently use and maintain (inventory and service).
- G. All fire extinguisher cabinets, if provided with locks, must be key operated by the standard Larsen LL24 key.

10 81 00 - Pest Control

Revised May 2013

Description

This section applies primarily to the exterior areas of the building relating primarily to controlling damage and limiting maintenance costs due to birds and other animals, as well as humans.

Design Standard

- A. The use of mechanical, electrical, physical, and chemical repellant systems, and protective devices specifically designed for bird and animal control shall not be allowed unless approved by the Capital Programs Management Group. It is preferred that the building design should address the elimination of possible roosting and rookery locations on window sills and shading devices by means of sloping top surfaces or other means acceptable to ASU.
- B. Openings in building facades for pipe penetrations and due to changes in materials shall be carefully detailed and constructed to eliminate possible entrance points into the building for bats, birds, insects, rodents and other animal pests. Mechanical seals are preferred as opposed to caulk based systems.

Special Notes Regarding Skateboards, BMX Bicycles, Bicycles and other devices that can damage surfaces campus wide (hereinafter referred to as skateboards): Potential damage and continuing maintenance to horizontal building elements due to skateboards should be taken into consideration in the building design. Freestanding railings and narrow copings at ground level are attractive to skateboard users and the sliding of the skateboards over these building elements requires constant maintenance, therefore these types of elements should be eliminated. The DP is to present a specific Skateboard deterrent plan to the PM during schematic design. The DP is not to proceed with any aspect of design that is accessible to this type of destructive activity unless it has been approved by the PM.

DIVISION 11 - EQUIPMENT

11 14 43 - Intrusion Detection/Duress Signal Systems

Revised May 2013

Description

This section applies to theft detection and security systems in any area of the building that utilizes materials that have a sensitive nature to them or in areas that have movable equipment and/or resource materials. In recent years, theft on campus has put a tremendous drain on financial resources of departments and is approaching epidemic proportions. All buildings should incorporate some type of theft detection system(s), and at the least some type of reporting system/ card access at all entries from the exterior, particularly in Residence Halls.

Design Standard

- A. In the architectural programming phase, the DP should assess, with the participation of ASU Police (ASUPD), ASU Electric Shop, and the Users, needs regarding security and the possible extent and type of that security. The program budget should reflect these discussions as a line item for future elaboration.
- B. No matter what type of system is developed, it will be required to directly report back to the ASUPD central computer station.
- C. All interfaces will have to be compatible with the control ASUPD system (e.g. Johnson Controls, ASU at Tempe campus, and Simplex, ASU at West campus). Contract Capital Programs Management Group for information regarding the existing control ASUPD system for each project at the various campuses.
- D. The DP shall review all technical requirements of the proposed system with ASUPD and ASU Electric Shop prior to design development.
- E. Current preferred system includes MOOSE or approved equal by ASU Electric Shop.

11 24 23 - Window Washing Equipment

Revised March 2010

Description

This section applies to exterior window washing support systems that will be required when a building is over 3 stories or 40' in height from average natural grade.

Design Standard

- A. The DP shall in the schematic design phase, work closely with a company or firm that specializes in the manufacturing and supply of the system. The system shall be an integral element in the design and not left as an oversight.
- B. Acceptable manufacturers of the equipment shall be Equicon, Spider Staging Sales Co., Swing Stage Inc., and Titan Staging and Engineering, Inc.
- C. A davit type system shall be utilized in the design of the building exterior. The system shall be designed with a total safety factor of 4 to 1 against overturning moment.
- D. All supports shall be welded construction. Supports shall be hot dipped galvanized after fabrication. Support sleeves shall be minimum schedule 40 steel pipe, conforming to ASTM A 53.
- E. Davit sockets shall be either mobile hinged or fixed type, designed with a total safety factor of 4 to 1 against overturning moment. Socket sleeves shall be minimum schedule 40 steel pipe, conforming to ASTM A 53. Sockets shall be hot dipped galvanized after fabrication.
- F. Cable tie backs shall be vinyl covered stainless steel cables, attached to the building with spring loaded, quick release fasteners and cables with spring loaded clips. All cable tie back receptacles shall be firmly anchored in the wall construction, per manufacturer's recommendation.
- G. ASU does not supply the actual movable platform, and should not be specified as doing so.
- H. A 6' minimum walkway shall be provided in all roof areas the system will need to operate to gain access to the building facade. This walkway may consist of a built-up cementous surface, raised industrial type walkway, or built-up pad, but it cannot compromise normal roof drainage or undermine the integrity of the roof in anyway.

11 52 13 - Projection Screens

Revised March 2010

IT Connections Required for Projection Screens

- A. The campus should provide satellite uplink/downlink capability to transmit live and taped program material to and from remote sites. Satellite transmission would be especially appropriate for educational outreach programs due to the increasing number of satellite receivers at homes and meeting sites.
- B. Receive only dishes should be located at remote campus locations, businesses, etc. to receive programming sent from the ASU campus.
- C. Each building with classrooms on campus should be connected by a campus-wide fiber optic distribution system. The system would allow distribution of live and taped programming from larger "sending" classrooms or from satellite feeds received through the satellite downlink.
- D. A transmission system should be provided that will allow audio teleconferencing in selected learning spaces. This system could be used for interactive training sessions between remote sites and should interface directly with the satellite uplink for communications consisting of one-way video with two-way audio.
- E. Large learning spaces should provide large screen, high quality video images with audio playback utilizing all formats of video sources.
- F. The designated transmission source "sending" rooms should be equipped with appropriate cameras and microphones to allow recording of events for playback or simultaneous transmission to remote sites.

General Recommendations

- A. All classrooms should have conduits linking them to (a) the campus-computer network, (b) the Educational Television and Radio Office's network (where appropriate), and (c) the campus telephone system.
- B. Selected rooms should be equipped with a video display device capable of handling signals from regular television and as many of the campus-supported computers as possible.

Since video images can be quite dim and susceptible to serious degradation from ambient light, lighting designs require special attention in rooms where video display devices require special attention.

Electrically Operated Projection Screens***Description***

This section applies to electrically operated projection screens. The standard does not include classrooms: for classrooms standards, see the *Classroom Design Guidelines*, provided by the Office of the University Architect (OUA). All other areas specified by ASU shall include screens that comply with the following requirements:

Design Standard

- A. Front projection screens, electrically operated with remote control switches.
- B. Each type of screen shall be specified as requiring complete units, including all mounting and accessory hardware, from a single manufacturer.
- C. Matte white viewing surface with:
 - 1. Minimum grain characteristics complying with FS GG-S-00172D(1) for Type A screen surface;
 - 2. Mildew and flame resistant glass fiber with vinyl coated viewing surface;
 - 3. Designed and fabricated for recessed installation.
- D. Edge treatment without black masking borders.
- E. Three position single switch station control.
- F. Size and location per applicable area as specified above in "Viewing Guidelines."
- G. Projection screens should be mounted at the front center of the room and are mounted approximately 3 inch from the wall to allow clearance of the chalkboard tray.
- H. The minimum project screen size is an 8'-0" x 8'-0" screen, ceiling recessed.
- I. Sightlines should be analyzed for all seats within the room.

Viewing Guidelines

These viewing guidelines are not for classrooms. See *Classroom Design Guildlines*, provided by the Office of the University Architect or OUA, for information pertaining to projection screens in teaching areas.

- A. In order for the most distant viewer to read projected characters and symbols, the viewer should not be more than 8 times the image height from the screen.
- B. In rooms where increased visual impact is desired, the viewer should not be more than 6 times the image height from the screen.
- C. The minimum distance to the first row of seats should be 2.5 times the image height from the screen.
- D. The maximum viewing angle for viewing should be 40 degrees when measured from the opposite edge of the projected image.

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- E. The distance from video monitor screens should be restricted to 4 to 6 screen diameters for laboratory, medical and technical viewing where image clarity and resolution are important; 5 to 10 screen diameters for general instructional viewing; and 10 to 12 screen diameters for general viewing where detail resolution is not important.

11 53 13 - Laboratory Exhaust And Fume Hoods*Revised May 2013***Description**

This section applies to exhaust and fume hoods in spaces designated for use as chemical laboratories. Laboratory fume exhaust systems must be designed as complete operating units considering chemical use factors, room supply air, room configuration, hood type and location, exhaust fan, and ductwork.

Laboratory design and specifications must be developed with guidance from the appropriate authority.

References

- ANSI/AIHA Z9.5 American National Standard for Laboratory Ventilation
- ANSI/ASHRAE 62, Ventilation for Acceptable Indoor Air Quality.
- ANSI/ASHRAE 110, Method of Testing Performance of Laboratory Fume Hoods.
- ANSI/ASHRAE 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
- ANSI/ASHRAE 41.2, Standard Method for Laboratory Air-Flow Measurement.
- ANSI/ASHRAE 41.3, Standard Method for Pressure Measurement.
- Biosafety in Microbiological and Biomedical Laboratories (BMBL)
- National Sanitation Foundation (NSF) Standard 49
- OSHA 29 CFR §1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories (Laboratory Standard).
- Prudent Practices in the Laboratory, Committee on Prudent Practices for Handling, Storage, and Disposal of Chemicals in Laboratories, National Research Council

Design Standard**A. General**

1. Hood exhaust ducts shall be sized for a transport velocity consistent with design noise levels, duct static pressure, size limitations and fan tip speed.
2. Hoods in air conditioned space are to have adequate outside make-up air. Fume hood fans shall be of industrial type, (American Blower, Buffalo, Clarage, or approved equal), properly protected against corrosive and flammable materials, weather-proofed, and belt driven.

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1. Fume hood exhaust through roof should have vertical fan outlet ducts that terminate at least 7' above roof. Discharge shall be directed vertically upward. If parapet walls are present, EHS recommends that stacks extend at least 2 feet above the top of a parapet wall or at least 7 feet above the roof, whichever is greater. New exhaust fans should be oriented in an up-blast orientation. Any other type of fan orientation increases the fan work load and increases the risk of exhaust emission re-entrainment. Hood exhaust stacks shall extend at least 7 feet above the roof. Recommend contacting the Office of the University Architect if any building features, such as exhaust stacks, extend above the roofline. Hood exhausts shall be located on the roof as far away from air intakes as possible to preclude re-circulation of laboratory hood emissions within a building. For toxic gas applications, the separation distance shall be at least 75 feet from any intake.
2. Where fume hoods are not installed initially but planned, provisions must be made for their later installation, in the form of ducts roughed in to the building structure or access provided for their subsequent installation.
3. Any volume or balance dampers used in a fume hood exhaust system shall fail-safe.

B. Flow Rates

1. Air exhausted from laboratory fume hoods and other special local exhaust systems must not be recirculated in the building. Chemical fume hood designs and fan systems will be selected for a range of 80-120 fpm average face velocity at an 18 inch sash opening per the manufacturer's performance specifications. For fume hoods requiring a greater face velocity, the hood system must also maintain containment and exhaust of containments with the sash open up to 18 inches. Exceptions to this range (80-120 fpm average face velocity) can be considered with a written hazard characterization and prior review/approval of ASU Environmental Health and Safety Department. Examples of exceptions may include, installation of manufacturer designed low volume flow fume hoods, during non-occupied use of the fume hood, or fume hoods not used as an engineering control for hazardous materials.
2. Discharge from exhaust stacks must have a velocity of at least 3,000 fpm (15.2m/s) unless it can be demonstrated that a specific design meets the dilution criteria necessary to reduce the concentration of hazardous materials in the exhaust to safe levels (i.e. Occupational Safety and Health Administration, OSHA, Permissible Exposure Limits). Achieving this velocity should not be done by the installation of a cone type reducer. The duct may be reduced, but the duct beyond the reduction should be of sufficient length to allow the air movement to return to a linear pattern. Mixed flow dilution exhaust fans may be used to address exhaust velocity needs.
3. Lab Hood Performance Commissioning. Proper operation of fume hoods must be demonstrated by a testing group coordinated by the contractor installing the fume hood prior to project completion. The ASU Project Manager is responsible for the initial performance test and balancing of the system.

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- a. The average fume hood face velocity alone is inadequate to describe performance. The combination of face velocity, cross-draft velocity, and airflow visualization tests are adequate. There are two recognized fume hood containment performance testing criteria. Either ASHRAE-110 Laboratory Fume Hood Performance Testing or qualitative testing criteria outlined in ANSI/AIHA Z9.5.

C. Biological Safety Cabinet Systems

1. The operational integrity of a new biological safety cabinets (BSC) must be validated by certification before it is put into service or after a cabinet has been repaired or relocated. It is be the responsibility of the faculty member to have the BSC tested and certified annually. The faculty member is also responsible for decontamination of the BSC. Certification will be performed by an accredited Biohazard Cabinet Field Certifier using the National Sanitation Foundation (NSF) Standard Number 49 for Class II Biological Safety Cabinets.

D. Perchloric Acid Exhaust Systems

1. Perchloric acid deposits in hoods and ductwork are potentially explosive and, therefore, such systems must be considered to be hazardous. The following items shall be considered:
 - a. Heated perchloric acid must only be used in a laboratory hood specifically designed for its use and identified as "For Perchloric Acid Operations." (Exception: Hoods not specifically designed for use with perchloric acid shall be permitted to be used where the vapors are trapped and scrubbed before they are released into the hood.)
 - b. Perchloric acid hoods and exhaust duct work must be constructed of materials that are acid resistant, nonreactive, and impervious to perchloric acid.
 - c. The exhaust fan should be acid resistant and spark-resistant. The exhaust fan motor should not be located within the duct work. Drive belts should not be located in the ductwork.
 - d. Ductwork for perchloric acid hoods and exhaust systems must take the shortest and straightest path to the outside of the building and shall not be manifolded with other exhaust systems. Horizontal runs shall be as short as possible, with no sharp turns or bends. The ductwork must provide a positive drainage slope back into the hood. Duct shall consist of sealed sections. Flexible connectors shall not be used.
 - e. Sealants, gaskets, and lubricants used with perchloric acid hoods, duct work, and exhaust systems must be acid resistant and nonreactive with perchloric acid.

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- f. A water spray system shall be provided for washing down the hood interior behind the baffle and the entire exhaust system. The hood work surface shall be watertight with a minimum depression of 13 mm (1/2 inch) at the front and sides. An integral trough shall be provided at the rear of the hood to collect wash-down water.
- g. Spray wash-down nozzles shall be installed in the ducts no more than 5 ft. apart. The ductwork shall provide a positive drainage slope back into the hood. Ductwork shall consist of sealed sections, and no flexible connectors shall be used.
- h. The hood surface should have an all-welded construction and have accessible rounded corners for cleaning ease. The hood baffle shall be removable for inspection and cleaning.
- i. Each perchloric acid hood must have an individually designated duct and exhaust system.

E. Hood locations and Disturbances

- 1. Cross drafts created by the room ventilation system, supply air diffusers, open windows, operable doors, personnel traffic, etc., can drastically disturb the flow of air entering the fume hood and cause a reverse flow of air out of the front of the fume hood. Room conditions such as these must be avoided by proper selection of ventilation delivery system, permanently locking windows, and proper locating hoods away from supply air diffusers and doors.
- 2. In no case should the velocity of cross drafts exceed 20 fpm or 20 percent of the average hood face velocity adjacent to the hood.
- 3. Velocity of supply air shall be no more than 50 to 70 fpm measured at the operator location in front of the hood while the hood is off and the sash open.

F. Noise

- 1. Noise measurements to be made at an average distance of one foot from the fume hood with the sash fully open, using a type 2 sound level meter per ANSI S1.4-1971 and an octave band filter for 31.5 to 4000 Hz.

G. Make Up Air-General Laboratory

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1. Laboratories with hazardous materials must have continuous air flow with a minimum of 6 air changers per hour (ACH) for laboratories. The minimum ACH also depends on the requirements of the specific lab space (i.e. 15 ACH for certain animal research facilities). Discharge of contaminated air must not be allowed to be recirculated into the laboratory building or adjacent buildings. Air exhausted from laboratory fume hoods and other special local exhaust systems must not be recirculated in the building. Laboratory ventilation systems must be designed to ensure that hazardous materials originating from the laboratory not be recirculated into the building. Non-laboratory air or air from building areas adjacent to the laboratory may be used as part of the supply air to the laboratory if its quality. Auxiliary air for fume hoods is limited to a maximum of 50% of the required fume hood flow rate.
 - (a) Labs equipped with demand based ventilation controls and air monitoring systems may be installed in ASU EHS Risk Level 1 and 2 labs and provide a minimum 4 ACH as long as the ACH rate increases to maximum ACH capacity of the lab ventilation system when the monitoring system identifies the demand for the increase.
2. Pressure differentials shall be maintained between rooms to insure a positive air movement from clean to more contaminated areas. Therefore, air supply should exceed air exhausted to office or classroom space and air exhausted should exceed air supplied to laboratory space.
3. Laboratory units must maintain air negative to corridors or adjacent spaces. Exceptions must be requested through ASU EH&S Department for review.

H. Hood Utilities

1. Controls for hood utilities shall be located outside the hood including any three-pronged receptacles for 110 v power. Hood electrical switches shall have indicator lights. Indication lights shall be installed to indicate proper blower operation.
2. Hood lighting shall be vapor-proof or explosion proof, depending upon the intended purpose of the hood. Light bulbs should be changed from outside the hood.
3. Plumbed cup sinks within hoods is discouraged. If hard plumbed, each sink or cup sink in a laboratory hood shall be individually trapped.

I. Storage

- a. Under hood storage units intended for hazardous materials (i.e. chemical, flammable liquids, gas, etc.) storage shall contain recessed flooring for spill retention, appropriate internal lining, and exhaust ventilated in order to maintain containment of materials. Units must be constructed to comply with the requirements of the International Codes and the Authority Having Jurisdiction.

11 53 43 - Laboratory Fixtures*Revised March 2010***Description**

This section includes laboratory sinks for installation in tops and laboratory emergency plumbing fixtures. All fixtures shall comply with all applicable trade and building codes and regulations, as well as all applicable portions of the National Sanitation Foundation Standards

Laboratory design and specifications must be developed with guidance from the appropriate authority.

Design Standard

- A. Cup Sink - Epoxy: Black, 3 inch x 6 inch oval with 1/4 inch raised lip at all hoods, as manufactured by Durcon, Epoxyn, or equal.
- B. Cup Sink - Epoxy: Black, 3 inch x 6 inch oval flush with benchtop at areas other than Hoods, as manufactured by Durcon, Epoxyn, or equal.
- C. Laboratory Sink - Epoxy: Black, at epoxy resin benchtops, size per Laboratory Furnishing drawings, as manufactured by Durcon, Epoxyn or equal.
- D. Laboratory Sink - Stainless Steel: Integral with stainless steel benchtop and as specified in Section 12 35 53 and detailed on plans.
- E. Animal Holding and Growth Room Sink - Stainless Steel: Manufacturer, Just or Elkay. Just #A47763 sink with J15FS drain and tailpiece and JS47TA-1 faucet with wrist blades.
- F. Built In Cooktop: Manufacturer - General Electric Model JP65IJ with (2) 8 inch and (2) 6 inch electric heating units. Provide cooktop in brushed chrome finish - 208V, 1 phase, 5.5 amps.
- G. Waste Disposer: Manufacturer - ISE model SS-75, 3/4 HP, 120V, 1 phase, 10 amps.
- H. Other Materials: All other materials, fittings, and products required including stoppers, strainers, and tailpieces, shall be new suitable for location and function, and in compliance with accepted submittals. All strainers shall be mechanically fastened.
- I. Angle Stops: Aquaflo 1/4 turn ball valve style or equal.
- J. P-Trap: Minimum size to be 1-1/2 inch diameter.

11 82 26 - Refuse Compactors

Revised March 2010

General

- A. A Provide solid waste compactor system. Provide complete installation of compactor and associated controls. Refer to ASU Design Standards, Division 26 (Electrical) for general requirements of power and controls to meet ASU standards.
- B. All items shall be stored in an enclosed shelter providing protection from damage and exposure to the elements.

Products

- A. Compactor shall be sized by ASU and shall be as manufactured by Marathon, or equal.
- B. Compaction cycle time shall be 30 seconds. Compactor shall automatically shut off and signal when container (bag if applicable) is full or when oversized or un-crushable objects are encountered. Access door shall be provided in side of hopper for manual feeding into compactor. Door shall be equipped with a shut off interlock to automatically prevent compactor from operating when door is open.
- C. Compactor shall be capable of generating a minimum of 25,000 lbs. of compaction force at 2000 psi. Adjustable ram force shall produce compaction ratio of 5 to 1.
- D. Control panel shall be mounted for ready accessibility on compactor or trash room wall and have the following: On/Off/Emergency Stop button and indicator lights for Power-On, Full Container, and Door Open.
- E. Hydraulic cylinder shall be per model specified.
- F. Compactor shall be constructed of heavy steel plate, welded and bolted together to form one continuous element.
- G. Sides of compactor shall be fabricated from 3/16 inch steel plate and compactor and ram bottom plates from 3/8 inch abrasion resistant steel. Ram face shall be reinforced 3/8 inch steel plate and sides 3/16 inch steel. Hopper shall be fabricated from 12 gauge sides with 3/8 inch steel back plate. Abrasion resistant steel shall have a Birnell Hardness of 360.
- H. Entire system shall be rust resistant primed and spray painted with an industrial grade enamel coating for resistance to damage or deterioration. Rough edges and weld splatter shall be ground smooth. Standard color shall be ASU Beige.
- I. Containers shall be per ASU capacity and be fabricated from 12 gauge steel reinforced at all stress points. Containers shall have heavy duty ball bearing swivels with phenolic resin wheels. Wheels shall not be less than 6: diameter. Rear load containers shall have four swivel wheels. Front load containers shall have 4 swivel wheels.
- J. Manually operated, lever actuated locking device shall secure container to both sides of compactor. Latching device shall be locatable on either side to permit container to be placed within 6 inch of wall opposite operator's side.

Execution

- A. All supplied items shall be installed in accordance with manufacturer's current guidelines.
- B. Additionally, ASU Grounds recommends that:
 - 1. Drains be installed in the area, as well as hose bibs and lighting;
 - 2. Bollards be installed behind each box;
 - 3. Electrical outlets be installed for maintenance purposes;
 - 4. Boxes have an 8-cubic-yard capacity and are slant-topped to allow dumping by front-end loaders.

DIVISION 12 - FURNISHINGS

12 20 00 - Window Treatments

Revised May 2013

Description

This section applies to interior applications of window coverings of exterior windows. This section is considered the responsibility, both in design and project estimating, of the DP, not the IDC. All window openings other than lobbies or corridors shall have window coverings. Miniblinds and other window treatments are to be purchased and installed under an State wide purchasing agreement by ASU. The DP is to work carefully with the PM to select an appropriate item for the intended use. The DP is to include in the documents and specifications instructions adequate to require the contractor to provide for the selected treatment in his construction activities (backing etc) as well as to coordinate the work of the Owner in installing the product. The contractor is to protect the window treatment from the time that it is installed until his construction is accepted by the Owner. Installations with damage caused by the contractor after installation by ASU will be replaced by the contractor at no cost to the Owner.

Design Standard

- A. Interior window assemblies shall be designed to accept horizontal mini blinds, bead chain operated; full tilting operation with slats rotating 180°. Tilt operator control to be on the left hand side of the blind.
- B. Blade thickness shall be 0.025 inch minimum, extruded solid polyvinyl chloride, with a 0.050 inch beaded edge.
- C. A color should be specified that facilitates easy maintenance and will not yellow or fade when exposed to direct sunlight. ASU at the Polytechnic campus requires color to match window/door trim.
- D. Acceptable manufacturers are Carey-McFall Corp., Graber Industries, Inc., Hunter Douglas, Inc., Levelor Lorentzen, Inc.; or manufactures which have equivalent quality. Coordinate with ASU Purchasing.

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- A. Classroom and laboratory uses may require enhanced window treatment. These treatments include motorized variable light reduction screens to total black out screens. In these instances, the DP is to work closely with the PM to determine the program requirement and to verify whether or not the item may be obtained under the ASU purchasing agreements. If not, the DP is to design and specify the item in the normal manner. If the item is to be procured and installed by the Owner, the process will be the same as for mini-blinds which is described above.

12 35 53 - Laboratory Casework And Benchtops

Revised March 2010

Description

This section applies to laboratory furnishings, casework, and tops. The work in this section requires close coordination with Divisions 22 and 26 in order to maintain orderly progress without removal of previously installed work, to prevent damage to finishes and products.

The use of modular or standardized, adjustable height lab benches are encouraged whenever possible to allow for reconfiguration.

Laboratory design and specifications must be developed with guidance from the appropriate authority.

Design Standard

- A. One full-size sample of finished base cabinet unit complete with hardware, doors, and drawers; finished wall-mounted cabinet complete with hardware, doors, and adjustable shelves; hinged and sliding doors; and sink units and accessories are required. Four samples of each type of specified finish and color are required.
- B. All tops and casework of the same material shall be the product of a single manufacturer.
- C. Benchtops:
 - 1. Molded epoxy resin tops shall be molded from a modified epoxy resin.
 - 2. Tops and curbs shall be a uniform mixture throughout their full thickness.
 - 3. Tops and curbs shall be non-glaring and black in color.
 - 4. Benchtops shall be 1-1/4 inch thick with drip grooves provided on the underside at all exposed edges. Further, all exposed edges, except as indicated below, shall be rounded to a 1/4 inch radius at front top edge and at vertical corners.
 - 5. Top set curbs at back and ends of benchtops shall be 4 inch high by 3/4 inch thick, bonded to the surface of the top to form a square joint.
 - 6. Sink cutouts shall be smooth and uniform without saw marks and the top edge shall have a uniform radius of approximately 1/8 inch.
 - 7. The bottom edge of the sink opening shall be finished smooth with the edge broken to prevent sharpness.
 - 8. Corners of sink cutouts shall be radiused not less than 3/4 inch.
 - 9. Indented bench tops shall be 1-1/4 inch thick at outer edge, indented 1/4 inch to provide a raised rim 1 inch wide around all exposed edges.
 - 10. The front top edge of the raised rim and exposed vertical corners of the top shall be rounded to a 1/8 inch radius.
 - 11. The juncture between the raised rim and the top surface shall be coved to a 1/4 inch radius.
 - 12. Physical Properties:

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- a. Flexural Strength (ASTM Method 0790-71) - 15,000 PSI
 - b. Compressive Strength (ASTM Method D695-77) - 35,000 PSI
 - c. Hardness, Rockwell M (ASTM Method D78-65) - 100
 - d. Water Absorption (ASTM Method D570-77)
 - e. % by weight, 24 hours - 0.02
 - f. % by weight, 7 days - 0.04
 - g. % by weight, 2 hour boil - 0.04
 - h. Specific Gravity - 1.97
 - i. Tensile Strength - 8,500 PSI
13. The benchtops shall be heat resistant and chemical resistant. Chemical resistance testing of the top may result in some discernible change in color or gloss, but no significant impairment of working surface function in life (an evaluation rating of "good" or better).
- D. Metal Casework
- All materials and methods used in construction shall conform to the best practices of the Scientific Laboratory Equipment Industry and Scientific Apparatus Manufacturers description.
1. Cold Rolled Sheet Steel shall be prime grade, roller leveled, and shall be treated at the mill to be free of scale, ragged edges, deep scratches, or other injurious effects. All gauges shall be U.S. Standard.
Metal Gages: 18 gauge, except as follows:
- a. Corner gussets for leveling bolts and apron corner braces shall be 12 gauge.
 - b. Hinge reinforcements, case and drawer suspension channels shall be 14 gauge.
 - c. Top and intermediate front horizontal rails, table aprons, and reinforcement gussets shall be 16 gauge.
 - d. Drawer assemblies, door assemblies, and adjustable shelves shall be 20 gauge.
2. Hardware and Trim
- a. Drawer and Door Pulls:
 - i. Drawer and door pulls are to be of a clean, modern design offering a comfortable hand grip, and shall attach to door or drawer with machine screws on 4 inch centers.
 - ii. Pulls shall be of extruded aluminum coated with a clear, air-dry lacquer.
 - iii. Two (2) pulls shall be furnished on drawers wider than 28 inch. Use of plastic pulls or other types subject to breakage will not be accepted.

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- iv. Drawers shall be self-closing from a point 5 inches out from the closed position.
- b. Hinges:
 - i. Hinges shall be made of stainless steel with brushed satin finish, and shall be the institutional type with a five-knuckle bullet-type barrel.
 - ii. Hinges shall be attached to both door and case with two screws through each leaf. Welding of hinges to door or case will not be accepted.
 - iii. Doors less than 36 inch in height shall be hung on one pair of 2-1/2 inch high hinges, and doors over 36 inch high shall be hung on 1-1/2 pair of 2-1/2 inch high hinges.
- c. Roll Point Catches: Roll point catches for doors shall be cadmium plated steel with spring action.
- d. Elbow Catches: Elbow catches and strike plates shall be used on left hand doors of double door cases where locks are used, and shall be steel, socket and pin type.
- e. Shelf Adjustment Clips: Shelf adjustment clips shall be nickel plated steel, socket and pin type.
- f. Leg Shoes:
 - i. Leg shoes shall be provided on all table legs, unless otherwise specified, to conceal leveling device.
 - ii. Shoes shall be 1-1/2 inch high and of a pliable, black vinyl material.
 - iii. Use of a leg shoe which does not conceal leveling device will not be acceptable.
- g. Support Struts:
 - i. Support struts shall consist of two 16 gauge channel uprights fastened top and bottom by two adjustable "U" shaped spreaders, each 12 gauge, 1-1/2 inch x length required.
 - ii. Struts shall be furnished to support drain troughs, and to support top at plumbing space under fume hood superstructures or other heavy loads.
 - iii. Support struts shall be furnished with hangers to support mechanical service piping and drainlines as shown on drawings. Support struts shall have a chemical resistant finish color.
- h. Knee Space Service Strip Cover Panels:

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- i. Shall be 18 gauge steel, of the same finish as cabinets, and shall be furnished at open spaces under counter top where no cabinets occur. They shall be easily removable and shall cover piping from underside of top of service ledge to floor.
3. Metal Casework Construction Performance:
 - a. Base cabinets shall be constructed to support a uniformly distributed load of 200 lbs. minimum per square foot of cabinet top area (total maximum of 2000 lbs.), including working surface without objectionable distortion or interference with door and drawer operation.
 - i. Base cabinet corner gussets with leveling bolts shall support 500 lbs. per corner, at 1-1/2 inch projection of the leveling bolt below the gusset.
 - ii. Each adjustable and fixed shelf 4 ft. or shorter in length shall support an evenly distributed load of 40 lbs. per square ft. up to a maximum of 200 lbs., with nominal temporary deflection, but no permanent set.
 - iii. Drawer assemblies shall automatically maintain alignment in cabinet opening and shall not bind during opening or closing of the drawer so as to minimize glass breakage and damage to fragile parts.
 - iv. Swinging doors mounted on base units shall support a 250 lb. load located at a test point of 14 inch measured horizontally front hinge along the top edge of door through a swing of 180 degrees. Weight test shall allow nominal temporary deflection, but no permanent distortion. Door assembly shall be twist-resistant and rigid, and shall close in a flat plane against the cabinet to permit the door catch at top of door to function properly.
4. Metal Casework Finish Requirements:
 - a. The completed finish system shall be certified to have no other effect other than slight discoloration, decrease in gloss or temporary slight softening of the finish film with no loss of adhesion and film protection as a result of chemical spot tests.
5. Acid Storage Base Cabinets:
 - a. Acid storage cabinets shall utilize the same gauges of metal and construction features as specified for other base cabinets above except that they shall be completely lined with a corrosion resistant liner.
 - b. A one-half width removable shelf of the same material as the liner shall be furnished with each cabinet.

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- c. Where specified, each cabinet shall be vented up as shown on drawings above the cabinet with a 1-1/2 inch PVC vent pipe. The bottom end of the vent pipe shall project through the back panel of the cabinet. The top end of the vent pipe shall be level to dished top, behind baffle in hood.
 - d. Provide 2 inch deep polypropylene pans to cover entire bottom of cabinet. Label cabinet "Acid Storage." Lettering size and style to match labeling of other special purpose metal cabinet
- 6. Solvent Storage Base Cabinets:
 - a. Solvent storage cabinets shall be specifically designed for the storage of flammable and combustible liquids. Construction shall be based upon the requirements listed by OSHA and NFPA No. 30, current edition, and cabinets shall be Factory Mutual approved and labeled.
 - b. The bottoms, top, sides, and doors shall be fabricated of 18 gauge steel and shall be all double panel construction with a 1-1/2 inch air space between panels. All joints shall be welded, or screwed, to provide a rigid enclosure.
 - c. The doors shall swing on full length piano hinges and shall be fully insulated and self-closing. The right hand door shall be equipped with a three point locking device and the left hand door shall have a full height astragal.
 - d. A 2 inch deep liquid tight pan that covers the entire bottom of the cabinet shall be furnished to contain liquid leaks and spills.
 - e. The shelves shall be heavy duty and shall be reinforced at all edges and down the center on the underside.
 - f. A grounding screw shall be provided at the back bottom corner.
 - g. The cabinet shall be completely finished both inside and outside with a paint finish that will meet the finish requirements of other metal casework above.
 - h. The cabinet shall be labeled in conspicuous lettering - "Flammable - Keep Fire Away." Lettering size and style to match labeling of other special purpose metal cabinets.
 - i. Cabinet shall be vented as shown on drawings with 1-1/2 inch IPS threaded vents with flame arrestors. Bottom end of the vent pipes shall project through the back panel of the cabinet. The top end of the vent pipes connect into the hood exhaust system above the fume hood.
 - j. At cabinets located remote from fume hood, vent pipe shall rise up in partition construction to make connection with fume exhaust system.
- E. Stainless steel for benchtops, sinks, and acid soak tank shall be Type 316 and shall be of gauge indicated on drawings or specifications.

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1. Autoclave enclosures, drying racks, canopy hoods, slotted exhaust and shelves shall be type 304 stainless steel.
 2. All fabrications shall have exposed surfaced ground and polished to a #4 satin finish.
 3. All stainless steel nuts, screws, bolts, and rivets, etc., shall be of the same type stainless as in the sheet material and shall have a tumbled finish closely resembling that of a #4 finish.
- F. Stainless steel tops shall be 16 gauge.
1. Stainless steel sides and backsplashes shall be integrally welded to top.
 2. Tops with sinks shall be fabricated with a marine edge and pitched to sink board for proper drainage. Marine edges shall be seamless die-formed.
 3. All stainless steel sinks shall be Type 316, 16 gauge. All sink joints shall be butt welded and ground smooth.
 4. Underside of sink shall have a heavy mastic agent coating providing sound deadening.

12 50 00 - Furniture Selection

Revised March 2010

Description

For classrooms and instructional spaces, see the *Classroom Design Guidelines*, provided by the Office of the University Architect (OUA). This section applies to seating, computer work stations, and the selection of other non-academic furniture. ASU strongly recommends the DP utilizes the expertise of an Interior Design Consultant in the programming phase to evaluate project furniture needs.

Capital Programs Management Group shall be provided a physical sample of each furniture item proposed for testing and approval. The DP will be responsible to obtain user group and any other approvals as required on a project by project basis.

12 50 00.01 - Classroom Worksurfaces

Revised March 2010

For classrooms worksurfaces standard, see the *Classroom Design Guidelines*, provided by the Office of the University Architect (OUA).

12 50 00.02 - Seating

Revised March 2010

Seating is an obvious contributing factor to overall comfort. Therefore, seating should be selected that will meet minimum comfort standards and still satisfy the requirements of International Building/Fire Codes, cost, durability, functional comfort, appearance/finish, and performance over time.

This standard for seating does not include classrooms, classroom auditoriums, or lecture halls. For classrooms, auditoriums or lecture hall standards, see the *Classroom Design Guidelines*, provided by the Office of the University Architect (OUA).

Design Standard

- A. Aspects to be considered when selecting seating in order to achieve minimum standards of comfort:
 - 1. Width of seat
 - 2. Type of Lumbar support in back
 - 3. Appearance
 - 4. Versatility of seating
 - 5. Replacement availability/Ease of maintenance
 - 6. Cost
- B. Seating Width
 - 1. Minimum comfort will range from 18 inch minimum to 22 inch maximum.
 - 2. The selection of seating width should be based upon the criteria set forth for the type of seating utilization described in the width selection matrix.
- C. Seating Back Support
 - 1. All seating shall have proper lumbar support.
 - 2. The back should have a slope ranging from 12 to 30 degrees for classroom seating.
 - 3. The height of the back should not exceed 34 inch from the floor level.
- D. Appearance
 - 1. The appearance shall be coordinated with the interior of the classroom and meet the acoustical requirements for the space.
 - 2. Soft coverings shall be used in large auditoriums or lecture halls where reverberation of sound is a problem.
 - 3. The construction and materials should be selected so that their color and surface are consistent with the other furnishing within the classroom.

SECTION 3: TECHNICAL GUIDELINES

E. Replacement Availability/Ease of Maintenance

1. Chairs shall be procured from manufacturers that demonstrate proven track records in the marketplace, and maintain stock levels that insure replacement can be made without timely backorder delays.
2. Chairs shall be selected that facilitate cleaning of the floor surface, and require minimum maintenance of the seat covering (if applicable).

F. Cost

1. High quality seating shall be purchased to minimize the long term life cycle costs since funding for equipment replacement, repair, and maintenance are becoming increasingly difficult to obtain.

12 50 00.03 - Computer Workstations

Revised March 2010

Description

Computer workstations should be provided that will meet the demands of the equipment, plus the necessary space for student materials. See the *Classroom Design Guidelines*, provided by the Office of the University Architect (OUA) for more information.

Design Standard

- A. Allow for a minimum surface area of six and one quarter (6.25) square feet to be provided.
- B. Furniture selection for computer workstations shall have provisions for securing the equipment and the furniture in the room.
- C. Additional ventilation is required if white marker boards are utilized due to marker fumes.
- D. Provisions for electrical fires should be considered for areas with computer workstations.

12 50 00.05 - Teaching Laboratories

Revised March 2010

Description

The following Teaching Lab Standards provide a generic overview of the situation encountered at Arizona State University. This section contains information of importance to the mechanical and electrical design. Ensure that this section is referenced in the appropriate divisions and sections. The standards are organized into three sections:

Section B covers the linear feet per section, minimum and maximum services per station, square feet per station and per student. Section C covers fume hood linear footage and services. Section D covers sinks and support space.

Teaching labs have unique requirements and the user must be consulted to establish requirements. Obviously, any particular laboratory design project would require specific study in order to determine whether a modification to these generic standards is required.

Design Criteria

A. Laboratory Types

- B1 - Dry Lab with No Fume Hoods or Support Space Use
- B2 - Dry Lab with No Fume Hoods Use but Support Space
- C1 - Wet Lab with No to Low Fume Hoods Use with Support Space
- C2 - Wet Lab with Medium Fume Hood use with Support Space
- C3 - Wet Lab with High Fume Hood Use with Support Space

SECTION 3: TECHNICAL GUIDELINES

B. Linear Feet per Section, Minimum and Maximum Services per Station, Square Feet per Stations and per Student.

ROOM TYPE	Linear Feet per Station		Minimum Services Per Station	Maximum Services Per Station	Square Feet per Station		Square Feet per Student	
	Min	Max			Min	Max	Min	Max
B1: Dry Lab	3.5	4.5	2-120V-15A duplex	2-120V-20A duplex G, LA, CW cupsink	17.5	25	42	55
B2: Dry Lab	3.5	4.5	2-120V-15A duplex	2-120V-20A duplex G, LA, CW cupsink	17.5	25	42	55
C1: Wet Lab	3.5	4.5	2-120V-15A duplex	2-120V-20A duplex G, LA, CW cupsink	17.5	25	42	55
C2: Wet Lab	4	6.5	2-120V-15A duplex LV, LA, CW cupsink	2-120V-20A duplex G, LA, CW cupsink 1/2 main sink	20	32.5	42	55
C3: Wet Lab	6	8	2-120V-15A duplex LV, LA, CW cupsink	2-120V-20A duplex G, LA, CW cupsink 1/2 main sink	20	32.5	42	55

C. Fume Hood Linear Footage and Services

ROOM TYPE	LF/Station or LF/Class		Minimum Services Per Station	Maximum Services Per Station
	Min	Max		
B1: Dry Lab	0	0	1-120V-15A duplex LA, CW cupsink	2-120V-20A duplex LA, CW cupsink
B2: Dry Lab	0	0	1-120V-15A duplex LA, CW cupsink	2-120V-20A duplex LA, CW cupsink
C1: Wet Lab	6'	6'	1-120V-15A duplex LA, CW cupsink	2-120V-20A duplex LV, LA, CW cupsink
C2: Wet Lab	1'/10	1'/12	1-120V-15A duplex LA, CW cupsink	2-120V-20A duplex LV, LA, CW cupsink
C3: Wet Lab	2'/1	5'/1	1-120V-15A duplex LV, LA, CW cupsink	2-120V-20A duplex LV, LA, CW cupsink

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D. Sinks and Support Space

ROOM TYPE	Fraction Per Min	Minimum Services Per Station	Maximum Services Per Station	SF Support Per Student Min Max	Support Services
B1: Dry Lab	1/18 1/9	HW, CW 18" x 24" sink	HW, CW 20" x 36" sink		
B2: Dry Lab	1/12 1/6	HW, CW 18" x 24" sink	HW, CW 20" x 36" sink	8 25	120V-15A duplex/ 120V-20A duplex CW cupsink
C1: Wet Lab	1/4 1/1	HW, CW, DW 18" x 24" sink	HW, CW, DW 12" x 18" sink plus share 20" x 32"	7 14	120V-15A duplex/ 120V-20A duplex CW cupsink
C2: Wet Lab	1/4 1/1	HW, CW, DW 18" x 24" sink	HW, CW, DW 12" x 18" sink plus share 20" x 32"	7 14	120V-15A duplex/ 120V-20A duplex CW cupsink
C3: Wet Lab	1/8 1/2	HW, CW, DW 20" x 36" sink	HW, CW, DW 12" x 18" sink per 2 students	7 14	120V-15A duplex/ 120V-20A duplex CW cupsink

12 93 00 - Site & Mall Furnishings

Revised March 2010

Description

This section applies to all furnishings exterior to the main confines of a building or exterior plazas, atriums and entry features. Features shall conform to the standards of this section, and where additional items are proposed but not included in this section, they shall be submitted to the ASU University Architect and the DRB for review and approval at the completion of the schematic design phase.

If additional items are approved for a specific project, then Supplier information and Specifications (including description, size and color of items) shall be furnished to ASU Grounds Services.

Design Standard

- A. Trash Receptacles
 - 1. Shall be an exposed aggregate cylindrical shape, 40 inches tall, 18 inch diameter, manufactured by Wausau Tile, tan in color.
- B. Cigarette Urns
 - 1. Shall match the trash receptacles in material, finish and color and shall be 24 inches high, 14 inch diameter, manufactured by Wausau Tile.
- C. Mall Benches
 - 1. Reinforced concrete. length 7'-10", height 2'-10", depth 2'-3"; light beige color of 1-1/2 inch San Diego Buff, sealed with Thompson water sealer; sack smooth finish (see sketch).
- D. Signs
 - 1. Exterior building signs are manufactured by the ASU Sign Shop and are installed by ASU Grounds Services. Information to the Shop shall include the building name, colleges (main office) and prime functions. The sign is deep brown in color, 48 inch high, 33 inch wide with 3-1/2 inch capped end posts. The panel is 24 inch x 32 inch, with 2 inch and 1 inch lettering.
- E. Bicycle Racks
 - 1. Bicycle racks are "owned" by Parking & Transit Services (PTS).
 - a. The racks shall be hot dipped galvanized original factory material. Prior to delivery to the jobsite, the rack must be factory finished as follows:
 - Sandblasted, cleaned, prepped and coated with three mils, minimum of fusion bond polyester powder;
 - Manufacturer/color to be Morton Thiokol "mineral bronze" number 33-9012, or equal;

SECTION 3: TECHNICAL GUIDELINES

- Coating to be fused by 101-9 process at maximum 500 degrees Fahrenheit;
- Racks are to be delivered to factory without primers, fillers, gaskets or other non-metal materials not capable of withstanding oven temperatures of 500° F;
 - (a) The bronze color specified above is common to all of the mall amenities on the campus;
 - (b) The coating is an electrostatic factory-applied process. Field application is not acceptable without prior approval.
 - (c) Bike rack pods must be well away from building entrances, wheelchair ramps, and existing or future dismount zones. Pods must be located in open, public places that are well frequented by the public and police patrols. Good lighting is also required.
 - (d) Racks must be spaced according to the following minimum requirements:
 - 2' between the side of a rack and any adjacent wall;
 - 2' between the end of a rack and any adjacent wall;
 - 2' between the end of a rack and the end of any adjacent bike rack;
 - 7' between the side of a rack and any adjacent bike rack;
 - No racks may be placed where they will come between any doorway and the mall or street on which the building is located, and;
 - The average space requirement for each rack is 85 square feet; minimum pod size is 8 racks or 80 spaces.
 - (a) Contractors are to deliver the racks to the approved site; and ASU Grounds Services will do the actual installations, unless a prior agreement has been reached.
 - (b) All plans that involve bike racks, parking pods, bike paths, or other traffic related concerns must be approved by the ASU Department of Public Safety and must adhere to recommendations in the Campus Transportation Master Plan and those of Parking & Transit Services.

B. Tables

1. Tables shall be provided where the DP may feel the design or surrounding features warrant such use. The same durability and simplicity in the design as the mall benches.

DIVISION 13 - SPECIAL CONSTRUCTION

13 12 00 - Fountains & Water Features

Revised March 2010

Description

This section addresses features in or around a project that utilize water as means of acoustic, aesthetic or micro-climate control features. In general, the use of water features are highly discouraged on Campus due to their poor record of performance, constant high maintenance and water conservation measures adopted by ASU and the State.

Design Standard

Not acceptable on campus unless specific approval is obtained.

DIVISION 14 - CONVEYING EQUIPMENT

14 20 00 - Elevators

Revised May 2013

Description

This section applies to the design and installation of passenger elevators.

- A. There shall be a minimum of 2 elevators for any building over one story, regardless of floor area or building type.
- B. In designing multi-elevated buildings, at least one car shall also be designed for occasional use as a freight elevator.
- C. The DP shall supply prior to the completion of the schematic design phase, a signed traffic analysis from a certified elevator supplier or a recognized elevator consultant company indicating the number of recommended elevators, types and speeds, for the project.
- D. Proprietary control equipment will not be acceptable. Electronic controls will require that all manuals, control diagrams, adjusting and operating information shall be supplied, along with "The Adjusters Tool" with password instructions and codes, to the owner.
- E. The tool, manuals, control diagrams, and instruction manual shall become the property of ASU. The adjuster's tool shall allow the current elevator maintenance contractor to make complete adjustments to all areas of the elevator.
- F. All PC boards and components shall be available to the Elevator Contractor holding the owner's elevator maintenance service contract. No system will be installed that does not meet this requirement, and will be replaced at the expense of general contractor, if installed and determined after installation to be proprietary in any way.
- G. All controls shall be designed and provided by either Motion Control Engineering, Inc. (MCE) or other company who supplies nonproprietary control equipment for the elevator industry. All others shall be approved by ASU Elevator Contract Administrator.
- H. All ADA handicap standards will be observed in design and installation using the most current adopted codes: ADAAG, ANSI A117.1, UFSA NE Handicap standards and ASME A17.1 will be met or exceeded.
- I. Electronic Door edges will be provided on all elevators using 150 or more microprocessor controlled infra-red light beams.
- J. Cab lighting shall be on emergency power or secondary power supply at ASU at the Tempe campus (battery backup will not be accepted). At the Polytechnic, ASU Downtown, or West campus, where no centralized emergency power is available, cab lighting by battery backup will be accepted.

SECTION 3: TECHNICAL GUIDELINES

- K. At least one elevator will be connected to emergency power through an automatic transfer switch. Elevators will be connected to normal building power for normal operation. If normal power source is lost, elevators will be automatically transferred to campus emergency power. If the building does not have an emergency backup power source or it is not capable of carrying the load, a Battery Powered Lowering device, MCE TAP's unit or equivalent, shall be provided and connected.
- L. Cab lighting will be recessed indirect fluorescent lighting or LED's with low current demand. Incandescent or halogens shall not be used.
- M. An automatic light and fan shutdown control system shall be installed that will evaluate the system activity and automatically turn off the cab lighting and ventilation fan during periods of inactivity. The settings shall be field programmable.
- N. Traveling cables shall contain 6-14 gauge conductors, 3 shielded twisted pairs for future security card readers. The elevator pit light shall be twin tube fluorescent light fixture in NEMA 4 rated.
- O. Warranty: To repair, restore or replace defects in elevator work materials and workmanship not due to ordinary wear and tear or improper use or care for 24 months from date of Substantial Completion.
- P. Furnish maintenance and call back service for a period of 24 months for each elevator from date of Substantial Completion during normal working hours, including callbacks.
- Q. Service shall consist of periodic examination of the equipment, adjustment, lubrication, cleaning, supplies and parts to keep the elevators in proper operation.

Design Standard

- A. General
 - 1. Power supply to be 480Y/277 volts (if available), 3 phase/60 cycle, 4 wire grounded system with soft starters.
 - 2. Main elevator power disconnects will be rated for 125% of the FLA continuous duty minimum, and shall not derated.
 - 3. A Phase I and Phase II fire service recall system should be provided for all elevators.
 - 4. Where fire sprinklers are installed in elevator shafts or machine rooms, a shunt trip breaker will be installed to separate all power from the elevators. This shunt trip will be operated by the fire alarm panel using a heat detector (not smoke) installed in the elevator shaft and in the machine room, per State Elevator Inspector.
 - 5. Any special fire protection systems (detection or suppression) for elevators must be connected to the building fire alarm systems that reports to ASU Dispatch.
 - 6. All elevator fire recall switches shall be operated by the Arizona State AZFS Key both inside the elevator and in the main lobby control switch. Fire recall switch shall override the normal custodial service switches but not the maintenance shutdown switches.

SECTION 3: TECHNICAL GUIDELINES

7. All special functions (air handler shutdown, fire and/or smoke door operation, fire dampers, audible alarms, visual alarms, elevator recall, smoke control systems and vents, fire curtains, the connection to ASU Police Services Dispatch, and special suppression system activations) must be designed to be bypassed by a supervised deactivating device or keyed switch at the local building fire alarm panel.
8. The audible and visuals must be designed so that it can be disabled without affecting any other special functions.
9. All deactivating devices must be at the panel and designed in a manner that will not require any tools. An access code that is supervised, or a keyed (ASU A, B key) operation that is supervised, shall be used.
10. On geared machines, provisions shall be made to manually bring car to floor level and open the car doors in case of complete power failure.
11. Machinery spaces shall be located to minimize vibration and noise, and be fully sound attenuated.
12. All wires in the travelling cables shall be terminated on a terminal board with permanent identification matching that used in schematic diagrams.
13. All relays, switches, resistors, overload devices, fuses, timers, etc., mechanically or electrically operated, shall be permanently marked with identification matching the shop drawings.
14. All field wiring must terminate at each control cabinet on properly identified terminal strips. Field wiring shall not terminate on equipment or relay studs. All control wiring shall be of stranded construction.
15. Temperature rise in windings shall not exceed 50°C above ambient in all testing modes.
16. All machinery rooms, where mechanical and electrical equipment is located, shall have a separate and independent air conditioning system installed. Air conditioning equipment shall be designed for a 72 degree indoor temperature. Machinery rooms shall maintain 75 degrees in the cooling mode.
17. Freight or service doors shall be electrically power operated to open and close.
18. No voice recorded messages on the elevator phone will be allowed. All calls shall be sent with auto dial directly to ASU Police Services Dispatch.
19. All elevators shall have a separate phone land line.
20. All elevator controllers shall have a network board for remote monitoring.
21. Provide a CAT6 connection for remote monitoring in each elevator equipment room at the controller.
22. Floor to ceiling car operating swing return panels (COP's) shall have added bracing support in the middle of the panel to prevent deflection when buttons are pushed.
23. Door Operation: Provide a direct current (DC) motor driven heavy duty operator designed to operate the car and hoistway doors simultaneously. Door movements

SECTION 3: TECHNICAL GUIDELINES

shall be electrically cushioned at both limits of travel and the door operating mechanism shall be arranged for manual operation in event of power failure. Closed-loop, microprocessor controlled motor-driven linear door operator, with adjustable torque limits, also acceptable. AC controlled units with oil checks or other deviations are not acceptable.

24. Machine-room-less elevators (MRL's) must have a 25-year life expectancy or end of life rated for 25+years, and free elevator belts every 5-years for 25-years.
25. One elevator must comply with International Building Code (IBC) Chapter 30 Section 3002.4 requiring one elevator to accommodate an ambulance stretcher 24" x 84".

B. Hydraulic

1. Hydraulic elevators shall be single stage piston type, limited to a maximum of 3 stories; 3,500 lbs. minimum capacity; 200 fpm minimum speed;
2. Car shall be fully handicapped accessible.
3. Machine room should be located adjacent to first car stop if possible.
4. No underground hydraulic lines will be accepted.
5. Oil Hydraulic Silencer: An oil hydraulic silencer (muffler device) shall be installed at the power unit location. The silencer shall contain pulsation absorbing material inserted in a blowout proof housing arranged for inspecting interior parts without removing unit from oil line.
6. For protection against chemical soil action or corrosion, wrap jack with spiral wrapping of specified tape. Wrap portion of jack unit beneath ground level, just prior to setting. Apply wrapping to provide double coverage.
7. The jack system will be supplied with schedule 40 PVC or steel sleeve protection system to prevent in ground corrosion of the casing.

C. Traction

1. Traction elevators (with variable speed drive) shall be used for buildings 4 floors or more; 3,500 lbs. minimum capacity; 250 fpm minimum speed; microprocessor controlled.
2. Car shall be fully handicapped accessible.
3. Hoistway doors shall be fully powered, especially if designed for freight usage in which the door openings shall be a minimum of 54 inches wide.
4. Traction elevators shall have load weighing devices.

14 27 00 - Passenger Cabs - Interior

Revised May 2013

Description

This section applies to the interior furnishing and finish of all passenger elevator cabs, regardless of whether they are hydraulic or traction type.

Design Standard

- A. Floor identification numbers shall include braille adjacent to control buttons and be a height from the floor that allows full floor button reach to the handicapped (hgt. to be determined by ASU disabled Student Resources prior to schematic design completion).
- B. Car and hall buttons to be illuminated tamper/vandal-proof devices.
- C. Car position indicator (PI) shall be LED's with travel signaled by lantern and gong.
- D. Lighting and signals shall be tamper/vandal resistant buttons with center jewels which illuminate to indicate that a call has been registered at the floor for the indicated direction -proof for both the cab COP and hall call stations.
- E. Hall Position Indicator: A vandal type position indicator shall be provided and mounted for optimum viewing. As the car travels, its position in the hoistway shall be indicated by the illumination of the alphanumeric character corresponding to the landing which the elevator is stopped or passing. When hall lanterns are provided, the position indicator shall be combined with the hall lanterns in the same faceplate. Faceplates shall match hall stations. Provide at all landings.
- F. Hall lanterns: A vandal type hall lantern with adjustable chime shall be provided at each landing and located adjacent to the entrance. The lanterns, when illuminated, shall indicate the elevator car that shall stop at the landing and in what direction the car is set to travel. When the car reaches a predetermined distance from the floor where it is going to stop, the corresponding hall lantern shall illuminate and the chime shall sound. The hall lantern shall remain illuminated until the car doors close in preparation for leaving the floor. Illumination of the arrow shall be with LED's. Faceplates shall match the hall station finish. Provide at all landings.
- G. Each car shall have a tamper-proof auto dialing telephone, reporting to ASU Police Services Dispatch.
- H. Walls shall be plastic laminate of a color that facilitates easy maintenance or #4 brush-finished Stainless Steel.
- I. The canopy and sills shall be extruded aluminum.
- J. The interior door front and transom shall be #4 finished stainless steel with front return and swing panel.
- K. The exterior surface of doors (room side) and entrance frames shall be finish with #4 stainless steel returns and trim.

SECTION 3: TECHNICAL GUIDELINES

- L. Ceilings shall be suspended, tamper/vandal resistant; lighting to shall be fluorescent fixtures or LED's supplying an average car lighting level of 30 foot candles.
- M. Floors shall be hard surfaced (rubber, tile, VCT, or equivalent etc.). Hard rubber flooring is to be Roppe or FLEXCO hard rubber tiles, 22-1/2 inch by 22-1/2 inch.
- N. Finish surfaces should be demountable or be fitted with brackets or holders to receive a protective blanket to protect surface when on and off loading material. Blanket buttons shall be permanently mounted to panel walls.
- O. All elevator cabs shall be supplied with an appropriate number of protective blankets for each elevator. The blankets shall be stored in the elevator equipment room when not in use.
- P. Each cab shall be supplied with 3 side continues stainless steel handrail, #4 finish mounted with set screws to pins for easy removal; emergency lighting and two speed exhaust fan.
- Q. Elevator pit shall have a sump pump flush mounted in the pit. The sump pump shall be capable of pumping 50 gallons per minute for each elevator sharing a common shaft. Provide pit with sump pump and holding tank. If hydraulic elevator, holding tank shall be large enough to hold all hydraulic fluid plus 25% of capacity of tank.
- R. For hydraulic elevators, provide a holding tank large enough to hold 125% of capacity of the hydraulic tank or an oil separator capable of handling the hydraulic capacity of the system.

DIVISION 20 - COMMON WORK RESULTS FOR MECHANICAL AND PLUMBING

20 00 00 - General Requirements

Revised May 2013

General

These guidelines have been established to address the most common project elements at ASU. They are to be used in conjunction with the requirements set forth by applicable codes, laws and ordinances of this jurisdiction, recognized industry standards, good industry practice and specific program needs. Omission of reference in these guidelines does not relieve responsibility for compliance with these requirements.

The provisions of these guidelines are not intended to prohibit the use of alternative systems, methods or components. Due diligence shall be performed to ensure the design is equivalent or superior to the prescribed elements of the guideline. Modifications to the guidelines shall be proposed to meet specific project goals, conditions and requirements through ASU's formal variance process.

Demolition

Abandoned utilities should be demolished back to the nearest main or riser as practical of the scope of the work area. Due to health concerns, all abandoned potable water piping shall be demolished back to the nearest main or riser so as to not create a dead leg where water could collect.

Confirm any materials that are to be salvaged and returned to ASU.

Installations

Distribution systems shall be installed level and plumb, without sags, and parallel and perpendicular to building structures and other systems and components in a neat and workmanlike manner. Each system shall be independently supported unless the support system has been engineered to accommodate the loads of the additional systems.

Provide access where serviceable equipment and components are located above hard lid ceilings, in chases, or in otherwise inaccessible locations.

Products

Unless directed by ASU to reuse components, use only products that are new, of first quality, and free from defects in workmanship and materials.

New products shall be by reputable manufacturers who have been manufacturing and distributing the product for at least five years unless otherwise approved by ASU.

Use the same manufacturer for like equipment or material as possible, unless otherwise indicated or directed by ASU.

20 00 00 - General Requirements

Revised May 2013

Systems and components shall be selected to maximize the utilization of competitive standard elements.

Products and materials shall be suitable for use, meeting system temperature and pressure requirements and be fire retardant, chemical, weather, UV resistant, etc. as required of the application. All products shall be asbestos free.

Vibration/Sound Control

Adequate isolation shall be provided at equipment, including the systems they serve, to minimize the transmission of vibration and noise from being transmitted to building components and occupied spaces. Unless otherwise noted in the project requirements, establish design goals according to good engineering practice and the ASHRAE design goals for sound control. For applications where controlling vibration and sound is critical, it is recommended that a vibration/acoustical consultant be engaged.

Isolators shall be selected and located to provide uniform loading and deflection based on the lowest disturbing operating frequency of the equipment. Flexible connections shall be compatible with the operating conditions of the system, weatherproof and fire resistant as required.

Piping

General

All materials shall be certified new from factory. Pipe, fittings and valves shall be made in the USA or Canada to ANSI/ASME standards and suitably stamped. Piping made in other countries shall not be used unless specifically approved.

Pipe systems shall be designed and installed to allow complete venting and drainage. Slopes shall be uniform without pockets. Automatic vents should be located on drawings and piped to a suitable and visible location.

Locate groups of pipes parallel to each other, spaced to permit future connections and servicing of valves.

Pipe shall not be routed through transformer vaults or above transformers, panelboards or switchboards, including required service space for the equipment, unless piping is serving this equipment.

Wrap piping when passing through sleeves. Pipe shall not come in contact with other systems or the building structure.

Pipe joints, no-hub clamps, flanges, unions, etc., shall not directly contact or be encased in concrete, or be located within wall, floor or roof penetrations.

All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. Bushings shall not be used.

Bull head tees shall not be used at converging intersections.

Provide a corrosion protection system for underground steel piping as recommended by soils engineer. System shall be provided by a contractor regularly engaged in such systems and supervised by an accredited engineer.

Evaporator and Cooling Coil Condensate Piping

Outdoor or Indoor:

Copper:

Pipe: Type M, drawn, ASTM B88.

Joints: 95-5 tin-antimony solder, ASTM B32.

Fittings: Wrought copper, ASTM B16.22.

Indoor Only (requires preapproved variance by ASU) (special attention must be given to smoke generation):

PVC:

Pipe: ASTM D1785, Schedule 40.

Fittings: ASTM D2665, solvent weld.

Provide union connection from equipment and threaded plug cleanouts at change in directions except for the final turndown to drain. Insulate as necessary if condensation may occur.

Solar Hot Water

Stagnant pipe systems may experience extreme high temperature conditions. Generally Type L or K copper, black steel and stainless steel are appropriate materials for the piping system, however when choosing materials for the collector loop, the solar system vendor should be consulted to understand the extreme conditions of the system being proposed. Care must be taken in using Teflon tape to seal threaded pipe joints when water /glycol is being circulated in the pipes. With proper dielectrics, black steel piping can be used on the collector side for use with glycol systems.

Fittings

Grooved fittings, and mechanically formed tee connections and couplings shall not be used.

Unions and Flanges

Unions and flanges shall meet the listed service and the applicable standards for the pipe materials used. Provide unions and/or flanges at equipment, valves and accessories that require maintenance and removal. Arrange valves, unions and flanges to allow for equipment removal without system shutdown. Provide dielectric unions or flanges at connections of dissimilar materials.

Valves and Specialties

Valves and specialties shall be located for convenience of operation and maintenance. Plans should clearly identify the location and/or provisions for accessibility, withdrawal of tube bundles and the like. The mechanical and architectural designs should be coordinated to show any platforms needed, or access panels in walls, ceilings, etc. as required for proper operation, maintenance or inspection of the system components.

SECTION 3: TECHNICAL GUIDELINES

Isolation valves shall be installed at each floor off of risers, each branch line off of mains, and each piece of equipment and terminal unit. They should be readily accessible for emergency or maintenance work. Provide gear operators for valves 6 inches and larger. In mechanical rooms, provide chain-wheel operators for valves 6 inches and larger, installed 96 inches or higher above finished floor elevation.

Install bypass valves around each pressure reducing valve/station and major equipment control valve using throttling type valves. If multiple, parallel control valves are installed, only one bypass is required. In this case, where differing capacity control valves are used (such as 1/3 - 2/3 configurations), size the bypass for the largest valve capacity. This requirement is not intended for control valves at terminal unit equipment unless required of the critical nature of the program.

Provide spring loaded type check valves on discharge of water pumps.

Where areas will be typically restricted, it is important that any serviceable equipment be located outside these areas.

Use rising stem or rising outside screw and yoke stems. Install valves in a position to allow full stem movement. Use extended stems where insulation dictates. Install valves with the stem at or above the centerline of the pipe.

Use threaded or flanged connections at valves.

Drains shall be full port ball valves with cap and chain.

Balancing valves shall not be used as isolation valves.

Gate valves (when approved) shall not be used as balancing valves.

Gauges

Install gauges on systems and equipment to aid in troubleshooting and where maintenance is required. Gauges shall be readily visible.

Pressure:

Minimum 4-1/2" dial, accurate to ANSI B40.1 Grade 1A.

Provide with snubbers and gauge valves.

Provide with coil syphons and gauge valves on hot pressure media such as steam systems.

At a minimum, provide at these locations:

- Building entrances.
- Suction and discharge of each pump.
- Upstream and downstream of each pressure regulating device.
- Upstream and downstream of filters, separators and pump strainers.
- Upstream and downstream of chillers and hot water heaters/boilers.
- Upstream and downstream of each coil, or coil bank, in air handling units.
- Pressurized tanks/receivers.

Temperature:

Pipeline mounted: minimum 9" with mercury free fill and adjustable angle stem.

Panel or remote mounted: minimum 4-1/2" dial.

At a minimum, provide at these locations:

- Building entrances.
- Upstream and downstream of main system mixing valves.
- Upstream and downstream of each, boiler, chiller and heat exchangers.
- Upstream and downstream of each coil, or coil bank, in air handling units.
- Upstream and downstream of each heat recovery unit.
- Upstream, downstream, and at each thermal storage tank.

Pressure/Temperature Test Stations

At a minimum, install upstream and downstream of:

- At each individual coil in air handling units with multiple coils.
- Each terminal coil.
- Each heat exchanger/converter.

Strainers

Provide drain valve at each strainer blowdown with hose threaded adapter and cap.

At a minimum, install upstream of:

- Each hydronic coil.
- Each control valve (not required for control valve is located downstream of a hydronic coil).
- Each pump.
- Each pressure reducing valve.
- Each steam trap.
- Each metering device.

Testing

The Design Professional shall specify testing procedures, including type of test, pressures and durations. At a minimum, such procedures shall comply with the requirements of the jurisdiction and recognized industry standards.

Verify systems are complete, flushed and clean prior to testing.

Isolate all equipment subject to damage from test pressure.

Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

SECTION 3: TECHNICAL GUIDELINES

Leave systems un-insulated, uncovered and unconcealed until it has been tested and approved. All pressure testing shall be witnessed and documented with results approved and signed off by an ASU representative and the Design Professional. Provide two week notice prior to witness test. Maintain a set of drawings for recording and sign-off of each tested section.

Where any portion of piping system must be concealed before completion of entire system, the portion shall be tested separately as specified for the entire system prior to concealment. Contractor shall expose all untested covered or concealed piping for testing.

Defective work or material shall be replaced or repaired as necessary and inspection and test repeated. Repairs shall be made with new materials.

In no case shall plastic piping be subjected to pneumatic testing unless specifically approved by the manufacturer.

Penetrations

General

Sleeves shall be provided for pipes and duct passing through walls or floors. Sleeves shall be cut flush with each surface unless otherwise specified. Sleeve sizes shall be a minimum of 1" larger in diameter than the pipe, and no more than 1/2" larger in all sides of duct. Sizes shall be adjusted as required of the firestopping system and to compensate for insulation without binding.

In bearing walls, masonry walls and partitions, and interior floors: pipe sleeves shall be standard weight steel pipe with smooth ends, and duct sleeves shall be 10 gauge galvanized sheet metal. All other sleeves shall be minimum 24 gauge sheet steel.

Where the floor, wall or partition is fire rated, provide a UL approved firestop/sealant system specific for the conditions, conforming to the construction assembly type, penetrating item type, annular space requirements and fire-rating for each separate instance.

Sealants shall be compatible for use with the penetrating item.

Exterior wall penetrations

Seal pipe penetrations through exterior walls using sleeves with integral water stop (formed) or split sleeves (cores) and modular, mechanical seals. Sealing system shall utilize 316 stainless steel bolts, washers and nuts. Other methods of sealing shall be considered where conditions dictate.

Interior wall penetrations

Seal around sleeve and annular space as required. Provide escutcheons on exposed side of piping.

Floor penetrations

Seal around sleeve and annular space as required.

In mechanical rooms above grade: pipe penetrations shall have 4" high water stopped curbs or sleeves around the pipe, and duct penetrations shall have 4" high water stopped curbs. All other floor penetrations shall extend a minimum of 1-1/2" above the floor.

20 05 13 - Motors

Revised May 2013

Motor installations shall comply with NEMA, IEEE, ANSI and NEC standards and listed when required. Motors shall be designed and protected for the environment and conditions in which they will perform. Motors shall be selected to not exceed the nameplate rating nor continuously operate into motor service factor. Motors shall be rated for continuous duty and have a 1.15 service factor unless required otherwise.

The minimum full load nominal efficiency for 1 hp and larger motors shall be premium efficiency type, established in accordance with NEMA MG-1 for the specific use of the motor. Motors less than 1/2 hp shall be single phase and furnished with built-in thermal overload protection. Motors 1/2 hp and larger shall be polyphase and provided with overload protection.

Select motors with sufficient hp rating for non-overloading operation over entire pump/fan curves.

Select motor controller features for the characteristics of the supply and control circuits and control sequence and duty cycle of the motor. Magnetic starters shall be provided for all motors over 1/2 hp and above. Provide reduced voltage starters as required to limit voltage sag in excess of 3%, or where other requirements dictate. Coordinate with ASU BAS the motors and equipment that will require control through the central building automation system.

Motors driven by variable frequency drives shall comply with the latest NEMA MG-1, Section IV, Part 31. Provide protection from bearing current damage as recommended by the motor manufacturer.

Motors less than 1/2 hp shall have permanently lubricated and sealed ball bearings. Motors 1/2 hp and larger shall have lubricating bearings with one grease fitting and one removable plug in the bottom of the grease sump per bearing to provide for flushing and pressure relief during lubrication.

Preference is for factory mounted motor starters to be provided with circuit breakers in lieu of fuses. Motor lead connections shall be made by industry approved methods of connection. Twist-on wire connections are not allowed.

The location of six and eight pole motors should be limited to on slab-on-grade applications.

20 05 29 - Supporting Devices

Revised May 2013

Support for all conditions of operation, including variations between static and dynamic loading. Systems shall be designed to allow for proper expansion and contraction. Such expansion and contraction should be controlled with hangers and supports as required to lessen forces and moments on equipment, and reduce the over-stress of the piping itself.

The use of expansion loops (non-flexible) is preferred over expansion joints unless the arrangement is such that only an expansion joint can meet the conditions. In particular, expansion joints should be avoided for steam systems, utilities in tunnels and areas where a leak would be extremely hazardous or costly. Where expansion joints are used, they shall be fully accessible for repair/replacement.

Anchor points should be shown on the drawings. Check to see that the structure which serves to anchor the piping is adequate for the force exerted. Any additional steel required should be detailed on the plans.

Where cold springing is used to control expansion, the amount and point of application should be shown on the plans.

Thrust blocks and restraints shall be provided as necessary to prevent movement of underground mechanical joints unless an approved joint system is used.

Insulation shall be sufficiently protected at each support to prevent damage due to static and dynamic loading with shields and inserts, saddles, etc. Material, thickness, compression strength, vapor barrier treatment and load bearing surface shall be considered for each system. Wood inserts are not allowed.

Isolate all bare copper pipe from ferrous building materials. Tape wrap is not an acceptable isolator.

Provide vinyl-coated hangers for all plastic piping.

20 05 53 - Identification

Revised May 2013

Pipe Identification:

Identify piping in accordance with ANSI Standard A13.1. Place markers:

- Near valves, flanges and changes in pipe direction.
- At both sides of ceiling, wall or floor penetrations.
- At any line entry point.
- At frequent intervals on straight pipe runs not less than every 25.
- Not less than once in each room.
- At each branch.
- Adjacent to each access door or panel
- Locate pipe markers so they are visible from the point of normal approach.
- Provide arrows at one or both ends of the label to indicate direction of flow.

Valve Identification:

Identify valves with brass tags and chains with 1/2" black characters. Use stainless steel chains for stainless valves. Coordinate valving tag numbering sequence with FDM.

Equipment Identification:

Identify all equipment with engraved laminated plastic with white lettering and black background. Lettering/numbering will be no less than 3/4" in height. Nameplates exposed to sunlight will be made of UV resistant material.

Provide operational data including manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

20 07 00 - Insulation

Revised May 2013

Insulation shall be provided in accordance with ASHRAE 90.1 and good engineering practice. Additional systems requiring insulation, or additional insulation thickness over the ASHRAE minimum, shall be provided where operating cost savings will offset the cost of the insulation within its life expectancy, to provide additional protection to building components and occupants and to prevent condensation.

Materials shall be fire retardant, moisture, mildew and weather/U.V. resistant, vermin proof and suitable for its service. Pipe insulation inserts shall be crush and rot resistant. Wood inserts are not allowed. Provide jackets to protect insulation from damage and/or reduce vapor transmission.

Exterior rectangular duct insulation shall be pitched to prevent ponding. Exterior pipe and round duct insulation jackets shall overlap and terminate at 45 degrees below horizontal to prevent water from seeping into the jacket.

All exposed insulation installed up to 6' above finished floor shall be further protected from damage with lagging.

Install materials with joints and terminations to readily allow access to equipment and components where inspection, service or repair is required, and to allow for system expansion/contraction without damaging the materials.

Vapor barriers shall be installed on insulated pipes, ducts and equipment having surface operating temperatures below 650F. Other conditions may warrant the application of vapor barriers on surfaces above this temperature and shall be analyzed on a case-by-case basis.

Installation methods shall be performed in accordance with the latest edition of the National Commercial and Industrial Insulation Standards manual and manufacturer's installation instructions. Use full length factory furnished material where possible; scraps are not allowed.

DIVISION 21 - FIRE SUPPRESSION

21 10 00 - Fire Protection Systems

Revised May 2013

All current NFPA codes and standards shall apply with the additions noted below

A. Acceptance

1. Prior to any test by ASU and/or the Fire Code Official, a complete system with no troubles or alarms (Green Panel) must be confirmed. Testing will be at the discretion of the State Fire Marshal and/or the ASU Fire Marshal in conjunction with the fire testing crew. A stamped/approved plan by the Authority Having Jurisdiction (AHJ) must be on site to review for testing and any alterations to approved plans must be hand written on the plans. AHJ is the immediate and legal government fire safety professional.
2. A copy of “as-built” drawings shall be provided by the contractor prior to the scheduled time of test to be kept and used by our department at their discretion. In addition, a digital set of as-built sprinkler system plans shall be provided and shall include information for every individual sprinkler head location, which identifies the manufacturer, model, temperature rating and date of manufacture for the head that was actually installed. In addition, a digital summary shall also be provided which lists all the individual types of heads installed for the whole building, and the total number installed of each type. It is the responsibility of the sprinkler contractor to verify in the field that the inventory accurately represents the heads that were actually installed. Reliance solely on the approved shop drawings is not acceptable.
3. A complete, accurate and up-to-date points list shall be provided (hard copy and digital) by the fire alarm contractor prior to the time of test showing each device address, type and location to be kept and used by our department at their discretion.
4. All trades involved with the fire alarm system (including but not limited to: building contractor, fire alarm contractor, elevator contractor, electrical contractor, mechanical contractor, fire sprinkler contractor, etc.) shall be present at scheduled time of acceptance test to provide all necessary time and material to test each and every individual device involved in the proper operation of the fire alarm system. Tests are conducted to confirm all required functions/operations of the system are compliant prior to final AHJ acceptance test.
5. It is recommended a five-day notice prior to scheduling of acceptance test to alleviate the scheduling conflicts involved in allocating time to prepare and conduct such test. All notices must be in writing via letter or email and must include all fire safety personnel and the ASU project manager.
6. A valid work order number with funds is necessary to cover the time and material involved in conducting the 100% acceptance inspection test.

B. Materials

1. Carbon steel, specified and installed in accordance with NFPA 13.

21 10 00 - Fire Protection Systems

Revised May 2013

SECTION 3: TECHNICAL GUIDELINES

2. Grooved pipe shall be roll grooved; no grooving that removes material from the pipe shall be allowed.
3. No plastic pipe of any type may be used on any fire protection system.
4. Hooking collar assemblies shall not be used for connecting sprinklers or drop nipples to sprinkler pipe.

C. Design standard

1. In buildings with sprinklers, fire pumps and/or standpipes, separate water service for fire protection shall be provided, and shall not be through the domestic metered water service.
2. In all buildings, other than the branch lines protecting such equipment, no mechanical joints will be allowed in electrical or communications equipment rooms. If piping must pass thru, then all joints shall be welded.
3. In all buildings with fire alarm systems, all control valves, including post indicator and wall indicator valves, shall be electrically supervised by the fire alarm panel. At all locations that control valves are concealed above ceilings or behind access doors, a sign shall be provided on the ceiling below the valve or the access door indicating the location of the control valve. In residential buildings, all control valves that are located in spaces accessible by the occupants of the building shall be provided with lockable tamper prevention devices and locks (that shall be specified by the University). Control valves shall only be installed in corridors, stairwells, mechanical rooms, fire pump rooms and sprinkler valve rooms and shall be easily accessible. The control valves shall be accessible with the use of no more than a six-foot stepladder. Provide 24" x 24" access door for valves located above inaccessible ceiling types. Control valves shall not be installed, above or below ceilings in classrooms, offices, conference rooms or any dormitory living quarters. Each control valve shall be supplied with a sign indicating the area of the building that is served by the valve.
4. At all locations that inspector test valves (ITV) are concealed above ceilings or behind access doors, a sign shall be provided on the ceiling below the valve or on the access door indicating the location of the ITV. Inspector test valves shall only be installed in mechanical rooms, corridors, stairwells, fire pump rooms, sprinkler valve rooms and custodial closets and shall be easily accessible. The ITV's shall be accessible with the use of no more than a six-foot stepladder. Inspector test valves shall not be installed, above or below ceilings, in classrooms, offices, conference rooms or in dormitory living quarters or in any area requiring entry through a classroom, office, conference room or any dormitory living quarters. Inspector test valves discharge shall be piped to a drain capable of handling the discharge at full flow or to the exterior of the building.
5. Drain valves shall only be installed in corridors, stairwells, mechanical rooms, fire pump rooms and sprinkler valve rooms and shall be easily accessible. The drain valves shall be accessible with the use of no more than a six-foot stepladder.

SECTION 3: TECHNICAL GUIDELINES

6. Drain valves shall not be installed, above or below ceilings, in classrooms, offices, conference rooms or in dormitory living quarters, or in any area requiring entry through a classroom, office, conference room or any dormitory living quarters.
7. Main drains discharge shall be piped to the exterior of the building. Auxiliary drain valves discharge shall be piped to a drain capable of handling the discharge at full flow or to the exterior of the building.
8. All ITV's and drains piped to the exterior shall drain onto a splash block and be in such a location as to not flood sidewalks and malls, building entrances or any location that will disrupt normal pedestrian traffic.
9. No sprinkler heads from any manufacturer, which incorporate a rubber O-ring, shall be permitted to be installed in university buildings. If a unique situation exists where a head with a rubber O-ring is the only type that will work, specific permission to use the head must be obtained from the university on a case-by-case basis.

D. Drawings

1. One "as built" drawing shall be supplied for Capital Programs Management Group's Print Room.
2. All fire protection systems as shall be identified in AutoCAD on floor plans. ASU must be supplied with one hard copy and a CD, identifying the locations of every item on the legend that follows.

DIVISION 22 - PLUMBING

22 11 00 - Facility Water Distribution

Revised May 2013

Part 1 - Products

Building Domestic Cold Water

Below Ground:

Copper (2-1/2" and Smaller):

Pipe: Type K, annealed, ASTM B88.

Joints (when allowed): Lead free solder, ASTM B32. Joints are not allowed under concrete, below grade.

Fittings: Copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.26.

Ductile Iron (3" and Larger)

Pipe: Ductile iron, Class 52, AWWA C151, cement mortar lined, AWWA C104.

Fittings/Joints: Mechanical joint with restrained, elastomeric gasket and non-toxic lubricant, AWWA C111.

Encasement: Polyethylene encasement of pipe and fittings, AWWA C105.

Above Ground:

Copper (2-1/2" and Smaller):

Pipe: Type L, hard drawn, ASTM B88.

Joints: Lead free solder, ASTM B32.

Fittings: Cast bronze, ANSI B16.18; wrought copper, ANSI B16.22.

Joints: Copper press-fit joints may be used with an approved variance by ASU.

Copper (3" and Larger):

Pipe: Type L, hard drawn, ASTM B88.

Joints: Brazed, AWS A5.8.

Fittings: Cast bronze, ANSI B16.18; wrought copper, ANSI B16.22.

Chrome plate finish any bare pipe subject to chemical exposure.

Building Domestic Hot Water

Below Ground:

Copper (All Sizes):

Pipe: Type K, annealed, ASTM B88.

22 11 00 - Facility Water Distribution

Revised May 2013

SECTION 3: TECHNICAL GUIDELINES

Joints (when allowed): Lead free solder, ASTM B32. Joints are not allowed below under concrete, below grade.

Fittings: Copper pressure fittings, ANSI B16.18; wrought copper pressure fittings, ANSI B16.26.

Above Ground:

Copper (2-1/2" and Smaller):

Pipe: Copper tube, Type L, hard drawn, ASTM B88.

Joints: Lead free solder, ASTM B32.

Fittings: Cast bronze, ANSI B16.18; wrought copper, ANSI B16.22.

Joints: Copper press-fit joints may be used with an approved variance by ASU.

Copper (3" and Larger):

Pipe: Type L, hard drawn, ASTM B88.

Joints: Brazed, AWS A5.8.

Fittings: Cast bronze, ANSI B16.18; wrought copper, ANSI B16.22.

Valves

Isolation Valves:

Ball valve, bronze body, full port, stainless steel ball and stem, quarter turn.

Butterfly valve, ductile iron body, lug type, stainless steel disc and stem.

Gate valves shall not be used unless preapproved by ASU.

Balancing Valves:

Globe valve, dezincification resistant brass or bronze, metering ports with position display, memory stop, multiple turn. Quarter turn valves shall not be used.

Water Hammer Arrestors

Provide water hammer arrestors at flush valves, quick-closing valves and where other potential locations for water hammer exists in accordance with Standard P.D.I. WH-201. Provide access panels at inaccessible locations.

Part 2 – Execution

General

Provide loose key hose bibs in equipment rooms, public restrooms and roofs for the purpose of cleaning and maintenance.

All water outlets dispensing non-potable water shall have signage posted noting – "Water Not for Consumption".

SECTION 3: TECHNICAL GUIDELINES

Any other piping arrangement that may allow water to stagnate shall not be installed within domestic water systems. Valves installed for future connections shall not extend more than 24" from an active main.

Install shut-off valves at each fixture and piece of equipment, at each branch take-off from mains, at the base of each riser, and at each battery of fixtures.

Provide accessible check valves in the individual cold and hot water fixture supply lines serving mixing valve type faucets or assemblies having hose connection outlets that are not equipped with integral check stops.

Install a shutoff valve immediately upstream of each strainer.

The water utilized for tests shall be obtained from a potable source of supply.

22 13 00 - Facility Sewerage

Revised May 2013

Part 1 - Products

Building Sanitary Waste and Vent, Storm Drainage

Underground:

Cast Iron (15" and smaller):

Pipe: Hubless, CISPI 301, ASTM A-888.

Fittings/Joints: Hubless with heavyweight no-hub couplings with stainless steel clamps, FM 1680 Class 1, ASTM C-1540.

PVC (15" and smaller) (requires preapproved variance by ASU):

Pipe: DWV, ASTM D2665

Fittings/Joints: Socket pattern with low Voc solvent cemented joints.

PVC (15" and larger):

Pipe: DWV, ASTM D2665

Fittings/Joints: Socket pattern with low Voc solvent cemented joints.

Forced Main Underground:

Copper (3" and smaller):

Pipe: Type K, drawn, ASTM B88.

Joints: Lead free solder, ASTM B32.

Fittings: Cast copper, ANSI B16.23; wrought copper, ANSI B16.29

Ductile Iron (4" and Larger)

Pipe: Ductile iron, Class 52, AWWA C151, cement mortar lined, AWWA C104.

Fittings/Joints: Mechanical joint with restrained, elastomeric gasket and lubricant, AWWA C111.

Encasement: Polyethylene encasement of pipe and fittings, AWWA C105.

Above Ground:

Copper (3" and smaller):

Pipe: Type M, drawn, ASTM B88.

Joints: Lead free solder, ASTM B32.

Fittings: Cast copper, ANSI B16.23; wrought copper, ANSI B16.29

Cast Iron (any size):

Pipe: Hubless, CISPI 301, ASTM A-888.

SECTION 3: TECHNICAL GUIDELINES

Fittings/Joints: Hubless with heavyweight no-hub couplings with stainless steel clamps, FM 1680 Class 1, ASTM C-1540.

Forced Main Above Ground:

Copper (2-1/2" and smaller):

Pipe: Type L, drawn, ASTM B88.

Joints: Lead free solder, ASTM B32.

Fittings: Cast copper, ANSI B16.23; wrought copper, ANSI B16.29

Galvanized (3" and larger):

Pipe: Sch. 40, Type F, Grade A, ASTM A53.

Fittings: Cast iron threaded drainage fittings, ASTM B16.12.

Laboratory Waste and Vent:

Underground:

Cast Iron:

Pipe: High silicon, hubless, ASTM A518, similar to Duriron.

Fittings: Heavyweight no-hub couplings with stainless steel clamps.

Polypropylene:

Pipe: Schedule 80, ASTM D4101, plain end, similar to Orion "Rionfuse"

Fittings: Socket fusion.

Above Ground:

Polypropylene:

Pipe: Schedule 40, ASTM D4101, flame retardant, ASTM D635, plain end, similar to Orion "Rionfuse".

Fittings: Socket fusion.

Sumps and Ejectors

Pumps shall be epoxy or enamel cast iron, duplex type with lead-lag operation. Oil filled and air filled applications should be considered on an individual basis.

Submersible type sewerage pumps are preferred. Solid handling only. No grinder pumps. No self primers.

Part 2 – Execution

General

Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with

SECTION 3: TECHNICAL GUIDELINES

common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees.

Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

Minimum size drain or vent pipe below slab shall be no less than 3".

Test tees shall be used for testing waste and vent systems. Do not separate piping systems and cap ends for testing.

Floor drains shall be installed in equipment rooms, restrooms and locker rooms. Refer to Engineering Guidelines for equipment room requirements.

All unburied change of direction fittings within the roof drainage system shall be braced against thrust loads that might result in joint separation due to dynamic forces caused by sudden, heavy rainfall conditions.

Sewer lines that pass through tunnels shall be continuous pipe without joints and penetrations and shall be sealed water tight.

Do not lay underground pipe directly on undisturbed or virgin soil. Provide an adequate homogenous layer of loose native or borrow backfill below and surrounding underground pipes to provide an even support for the pipe, improve drainage and reduce corrosion.

Cleanouts

Provide two-way clean-outs on building drains, outside the building.

Provide cleanouts at locations and with clearances as required by the code, at the base of each stack. Intervals shall not exceed 50 feet in horizontal runs without a variance. In no case shall the intervals exceed 70 feet.

All interior cleanouts shall be accessible from walls or floors. Provide wall cleanouts in lieu of floor cleanouts wherever possible. A floor cleanout shall be installed only where installation of a wall cleanout is not practical. Coordinate the location of all cleanouts with the architectural features of the building.

Provide a wall cleanout for each water closet or battery of water closets. Locate wall cleanouts above the flood level rim of the highest water closet but no more than twenty four inches above the finished floor.

Lubricate cleanout plugs with anti-seize lubricant before installation. Prior to final completion, remove cleanout plugs, re-lubricate and reinstall using only enough force to provide a water and gas tight seal.

Sumps and Ejectors

Connect to standby power. Provide high water limit alarm locally and at ASU BAS.

Sumps and ejectors shall vent through roof separate from the building vent.

Use ball type check valve for submersible pumps. Flapper or disc type are not to be used unless sewerage rated.

22 16 00 - Natural Gas

Revised May 2013

Part 1 - Products

Below Ground

Coordinate with local utility.

Above ground

Carbon Steel:

Pipe: Carbon steel, Schedule 40, Grade B. Use A53 below 5 psig and A106 above 5 psig.

Joints/Fittings: Shall be as required of pressure and size per NFPA and local codes.

Valves

Isolation valves:

Ball valve, bronze body, full port, chrome plated brass ball, blowout proof stem, TFE seat, quarter turn.

Ball valve, carbon steel body, stainless steel ball and stem, PTFE seats, quarter turn.

Part 2 - Execution

General

Avoid routing any gas piping underslab beneath buildings.

Gas piping shall not to be used as a ground.

Provide dirt legs, drain tees and plugs at equipment and appliances.

Branch connections shall be made at the top or side of the main.

22 44 00 - Plumbing Fixtures

Revised May 2013

Part 1 - Products

Electric Drinking Fountains

Fountains shall have a stainless steel bowl and drain with flow restricting bubbler and push-bar operation.

Provide with hermetic compressor utilizing non-ozone depleting refrigerant. Front panel shall be removable and unit shall be constructed that the refrigeration unit can be removed without removing the cooler from the wall. Remote compressors shall not be used.

Urinals

Low flow urinals, 0.125 gpf, are preferred over waterless urinals. Where waterless urinals are installed, do not install trap arms.

Part 2 - Execution

Electric Drinking Fountains

All drinking fountains shall be barrier free and installed per ADAAG.

New construction and major renovations shall provide a minimum of two drinking fountains per floor.

Emergency Eyewashes>Showers

Equipment does not have to meet the requirement for tepid water.

22 61 00 - Common Utilities For Laboratory Facilities

Revised May 2013

Part 1 – Products

General

The guidelines below are intended for building above ground applications only. Each application shall be specifically addressed to identify purity requirements that may exceed the materials below. Consult EH&S and ASU PM regarding piping requirements for hazardous or corrosive media.

Compressed Air, Nitrogen and Carbon Dioxide

Copper:

Pipe: Type L, hard drawn, cleaned and capped, ASTM B280.

Joints: Brazed, AWS A5.8, BCuP-5.

Fittings: Wrought copper, ANSI B16.22, cleaned and bagged.

Isolation Valves (3" and smaller):

Full port, 3-piece, bronze body, stainless steel ball and stem, oxygen cleaned and bagged.

Vacuum

Copper:

Pipe: Type L, hard drawn, ASTM B88

Joints: Lead free solder, ASTM B32.

Fittings: Cast copper, ANSI B16.23; wrought copper, ANSI B16.29

Isolation Valves (3" and smaller):

Ball valve, 3-piece, bronze body, full port, stainless steel ball and stem.

Isolation Valves (4" to 6"):

Butterfly valve, ductile iron, lug type, stainless steel disc and stem.

RO/DI Water

For use with maximum 100PSIG @ 80F operating pressure and temperature limits and sizes indicated.

PVC (6" and smaller):

Pipe: PVC1120, Schedule 80, ASTM D-1785.

Fittings/Joints: Socket pattern with solvent cemented joints suitable for use on potable water, ASTM D-2467.

Valves shall be same material and manufacturer as piping.

Air Compressors

Main building compressors shall be duplex (or triplex) and operate in a lead-lag fashion.

Compressors shall be oil free.

Water conservation options shall be considered.

Vacuum Pumps

Main building pumps shall be duplex (or triplex) and operate in a lead-lag fashion.

Liquid ring pumps are preferred.

Water conservation options shall be considered.

Part 2 – Execution

General

Provide isolation valves at each floor, at each laboratory and at each piece of equipment.

Laboratory isolation valves shall be located outside the laboratory proper.

Branch connections shall be connected made at the top of the main for all laboratory gas, vacuum and water piping.

Vacuum

Provide line sized cleanout at end of mains for flushing.

Size and arrange exhaust stack to prevent moisture and back-pressure from entering pump.

Provide valved drip leg at base of exhaust stacks.

RO/DI

Provide system with self-closing valves and faucets.

Route piping in a loop configuration to minimize dead legs. Dead legs over 12” are not allowed.

DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

23 05 93 - Testing, Adjusting, And Balancing For Hvac

Revised May 2013

General

All work shall be performed by an independent test and balance Contractor and under the direction of a Certified Test and Balance Engineer. The Contractor's technicians shall meet the qualifications of the Contractor's certification agency. TAB firm shall be certified by either AABC or NEBB with a minimum of five years' experience.

Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems", NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.

Use standard forms from AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" whenever possible. Five (5) copies of the test and balance report are required and shall be submitted to the Owner for approval. In addition, a copy of all approved test and balance reports shall be included in each copy of the Maintenance Manual.

TAB work shall not proceed until all assigned personnel have been approved by Architect/Engineer. Coordinate each phase of TAB work with overall project schedule. Fieldwork must be completed before occupancy. Certificate of Substantial Completion shall not be issued until after Final Report is accepted by Architect/Engineer.

Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to project specifications.

Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings and to allow the settings to be restored.

The balancing agency shall not instruct or direct the mechanical contractor in any of the work. Any proposed changes or revision in the work shall be submitted to the DP in writing. The DP shall, in coordination with his engineer, process the proposal as appropriate.

Tolerances

Unless project specifications set tighter tolerances, HVAC system airflow and water flow rate tolerances shall not exceed the following:

23 05 93 - Testing, Adjusting, And Balancing For Hvac

Revised May 2013

SECTION 3: TECHNICAL GUIDELINES

Supply, Return, and Exhaust Fans and Equipment with Fans: Zero to plus 10 percent.

Air Outlets and Inlets: minus 5 percent to plus 10 percent (ensure room pressure requirements are maintained).

Heating-Water Flow Rate: 0 to minus 10 percent.

Cooling-Water Flow Rate: 0 to minus 5 percent.

Pre-Balance Report

If renovation is anticipated to affect more than 10 percent of an existing systems capacity, a system pre-balance report shall be performed prior to renovation to verify that sufficient system capacity is available for the proposed renovation, and that the renovation will not adversely affect non-renovated areas.

Final Report

Final Report Contents:

In addition to certified field report data, include the following:

- Pump curves.

- Fan curves.

- Manufacturers' test data.

- Field test reports prepared by system and equipment installers.

- Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

General Report Data:

In addition to form titles and entries, include the following data in the final report, as applicable:

- Title page.

- Name and address of TAB firm.

- Project name.

- Project location.

- Architect's name and address.

- Engineer's name and address.

- Contractor's name and address.

- Report date.

- Signature of TAB firm who certifies the report.

- Table of Contents with the total number of pages defined for each section of the report.

- Number each page in the report.

- Summary of contents including the following:

SECTION 3: TECHNICAL GUIDELINES

Indicated versus final performance.

Notable characteristics of systems.

Description of system operation sequence if it varies from the Contract Documents.

Nomenclature sheets for each item of equipment.

Data for terminal units, including manufacturer, type size, and fittings.

Notes to explain why certain final data in the body of reports varies from indicated values.

System Diagrams:

Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

Quantities of outside, supply, return, and exhaust airflows.

Water and steam flow rates.

Duct, outlet, and inlet sizes.

Pipe and valve sizes and locations.

Terminal units.

Balancing stations.

Position of balancing devices.

Include the following applicable information in the test reports for these common systems. Refer to project specifications for additional requirements.

Air-Handling Unit:

Unit Data:

Unit identification.

Location.

Make and type.

Model number and unit size.

Manufacturer's serial number.

Unit arrangement and class.

Discharge arrangement.

Sheave make, size in inches, and bore.

Sheave dimensions, center-to-center, and amount of adjustments in inches.

Number of belts, make, and size.

Number of filters, type, and size.

Motor Data:

Make and frame type and size.

Horsepower and rpm.

Volts, phase, and hertz.

Full-load amperage and service factor.

Sheave make, size in inches, and bore.

Sheave dimensions, center-to-center, and amount of adjustments in inches.

Test Data (Indicated and Actual Values):

Total airflow rate in cfm.

Total system static pressure in inches wg.

Fan rpm.

Discharge static pressure in inches wg.

Filter static-pressure differential in inches wg.

Individual coil static-pressure differential in inches wg.

Outside airflow in cfm.

Return airflow in cfm.

Individual damper positions.

Apparatus-Coil:

Coil Data:

System identification.

Location.

Coil type.

Number of rows.

Fin spacing in fins per inch o.c.

Make and model number.

Face area in sq. ft..

Tube size in NPS.

Tube and fin materials.

Circuiting arrangement.

Test Data (Indicated and Actual Values):

Airflow rate in cfm.

Average face velocity in fpm.

Air pressure drop in inches wg.

SECTION 3: TECHNICAL GUIDELINES

Outside-air, wet- and dry-bulb temperatures in deg F.

Return-air, wet- and dry-bulb temperatures in deg F.

Entering-air, wet- and dry-bulb temperatures in deg F.

Leaving-air, wet- and dry-bulb temperatures in deg F.

Water flow rate in gpm.

Water pressure differential in feet of head or psig.

Entering-water temperature in deg F.

Leaving-water temperature in deg F.

Refrigerant expansion valve and refrigerant types.

Refrigerant suction pressure in psig.

Refrigerant suction temperature in deg F.

Inlet steam pressure in psig.

Gas- and Oil-Fired Heat Apparatus:

Unit Data:

System identification.

Location.

Make and type.

Model number and unit size.

Manufacturer's serial number.

Fuel type in input data.

Output capacity in Btuh.

Ignition type.

Burner-control types.

Motor horsepower and rpm.

Motor volts, phase, and hertz.

Motor full-load amperage and service factor.

Sheave make, size in inches, and bore.

Sheave dimensions, center-to-center, and amount of adjustments in inches.

Test Data (Indicated and Actual Values):

Total airflow rate in cfm.

Entering-air temperature in deg F.

Leaving-air temperature in deg F.

Air temperature differential in deg F.
Entering-air static pressure in inches wg.
Leaving-air static pressure in inches wg.
Air static-pressure differential in inches wg.
Low-fire fuel input in Btuh.
High-fire fuel input in Btuh.
Manifold pressure in psig.
High-temperature-limit setting in deg F.
Operating set point in Btuh.
Motor voltage at each connection.
Motor amperage for each phase.
Heating value of fuel in Btuh.

Electric-Coil:

For electric furnaces, duct coils, and electric coils installed in central-station air-handling units.

Unit Data:

System identification.
Location.
Coil identification.
Capacity in Btuh.
Number of stages.
Connected volts, phase, and hertz.
Rated amperage.
Airflow rate in cfm.
Face area in sq. ft..
Minimum face velocity in fpm.

Test Data (Indicated and Actual Values):

Heat output in Btuh.
Airflow rate in cfm.
Air velocity in fpm.
Entering-air temperature in deg F.
Leaving-air temperature in deg F.
Voltage at each connection.

Amperage for each phase.

Fans:

For supply, return, and exhaust fans.

Fan Data:

System identification.

Location.

Make and type.

Model number and size.

Manufacturer's serial number.

Arrangement and class.

Sheave make, size in inches, and bore.

Sheave dimensions, center-to-center, and amount of adjustments in inches.

Motor Data:

Make and frame type and size.

Horsepower and rpm.

Volts, phase, and hertz.

Full-load amperage and service factor.

Sheave make, size in inches, and bore.

Sheave dimensions, center-to-center, and amount of adjustments in inches.

Number of belts, make, and size.

Test Data (Indicated and Actual Values):

Total airflow rate in cfm.

Total system static pressure in inches wg.

Fan rpm.

Discharge static pressure in inches wg.

Suction static pressure in inches wg.

Round, Flat-Oval, and Rectangular Duct Traverse:

Include a diagram with a grid representing the duct cross-section.

Report Data:

System and air-handling unit number.

Location and zone.

Traverse air temperature in deg F.

Duct static pressure in inches wg.

Duct size in inches.

Duct area in sq. ft..

Indicated airflow rate in cfm.

Indicated velocity in fpm.

Actual airflow rate in cfm.

Actual average velocity in fpm.

Barometric pressure in psig.

Air-Terminal-Device:

Unit Data:

System and air-handling unit identification.

Location and zone.

Test apparatus used.

Area served.

Air-terminal-device make.

Air-terminal-device number from system diagram.

Air-terminal-device type and model number.

Air-terminal-device size.

Air-terminal-device effective area in sq. ft..

Test Data (Indicated and Actual Values):

Airflow rate in cfm.

Air velocity in fpm.

Preliminary airflow rate as needed in cfm.

Preliminary velocity as needed in fpm.

Final airflow rate in cfm.

Final velocity in fpm.

Space temperature in deg F.

System-Coil:

For reheat coils and water coils of terminal units.

Unit Data:

System and air-handling unit identification.

Location and zone.

Room or riser served.

Coil make and size.

Flowmeter type.

Test Data (Indicated and Actual Values):

Airflow rate in cfm.

Entering-water temperature in deg F.

Leaving-water temperature in deg F.

Water pressure drop in feet of head or psig.

Entering-air temperature in deg F.

Leaving-air temperature in deg F.

Packaged Chiller:

Unit Data:

Unit identification.

Make and model number.

Manufacturer's serial number.

Refrigerant type and capacity in gal.

Starter type and size.

Starter thermal protection size.

Compressor make and model number.

Compressor manufacturer's serial number.

Water-Cooled Condenser Test Data (Indicated and Actual Values):

Refrigerant pressure in psig.

Refrigerant temperature in deg F.

Entering-water temperature in deg F.

Leaving-water temperature in deg F.

Entering-water pressure in feet of head or psig.

Water pressure differential in feet of head or psig.

Air-Cooled Condenser Test Data (Indicated and Actual Values):

Refrigerant pressure in psig.

Refrigerant temperature in deg F.

Entering- and leaving-air temperature in deg F.

Evaporator Test Reports (Indicated and Actual Values):

Refrigerant pressure in psig.

Refrigerant temperature in deg F.

Entering-water temperature in deg F.

Leaving-water temperature in deg F.

Entering-water pressure in feet of head or psig.

Water pressure differential in feet of head or psig.

Compressor Test Data (Indicated and Actual Values):

Suction pressure in psig (kPa).

Suction temperature in deg F.

Discharge pressure in psig.

Discharge temperature in deg F.

Oil pressure in psig.

Oil temperature in deg F.

Voltage at each connection.

Amperage for each phase.

Kilowatt input.

Crankcase heater kilowatt.

Chilled-water control set point in deg F.

Condenser-water control set point in deg F.

Refrigerant low-pressure-cutoff set point in psig.

Refrigerant high-pressure-cutoff set point in psig.

Refrigerant Test Data (Indicated and Actual Values):

Oil level.

Refrigerant level.

Relief valve setting in psig.

Unloader set points in psig.

Percentage of cylinders unloaded.

Bearing temperatures in deg F.

Vane position.

Low-temperature-cutoff set point in deg F.

Compressor and Condenser:

For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units:

23 05 93 - Testing, Adjusting, And Balancing For Hvac

Unit Data:

- Unit identification.
- Location.
- Unit make and model number.
- Compressor make.
- Compressor model and serial numbers.
- Refrigerant weight in lb.
- Low ambient temperature cutoff in deg F.

Test Data (Indicated and Actual Values):

- Inlet-duct static pressure in inches wg.
- Outlet-duct static pressure in inches wg.
- Entering-air, dry-bulb temperature in deg F.
- Leaving-air, dry-bulb temperature in deg F.
- Condenser entering-water temperature in deg F.
- Condenser leaving-water temperature in deg F.
- Condenser-water temperature differential in deg F.
- Condenser entering-water pressure in feet of head or psig.
- Condenser leaving-water pressure in feet of head or psig.
- Condenser-water pressure differential in feet of head or psig.
- Control settings.
- Unloader set points.
- Low-pressure-cutout set point in psig.
- High-pressure-cutout set point in psig.
- Suction pressure in psig.
- Suction temperature in deg F.
- Condenser refrigerant pressure in psig.
- Condenser refrigerant temperature in deg F.
- Oil pressure in psig.
- Oil temperature in deg F.
- Voltage at each connection.
- Amperage for each phase.
- Kilowatt input.

Crankcase heater kilowatt.

Number of fans.

Condenser fan rpm.

Condenser fan airflow rate in cfm.

Condenser fan motor make, frame size, rpm, and horsepower.

Condenser fan motor voltage at each connection.

Condenser fan motor amperage for each phase.

Cooling Tower or Condenser:

Unit Data:

Unit identification.

Make and type.

Model and serial numbers.

Nominal cooling capacity in tons.

Refrigerant type and weight in lb.

Water-treatment chemical feeder and chemical.

Number and type of fans.

Fan motor make, frame size, rpm, and horsepower.

Fan motor voltage at each connection.

Sheave make, size in inches, and bore.

Sheave dimensions, center-to-center, and amount of adjustments in inches.

Number of belts, make, and size.

Pump make and model number.

Pump manufacturer's serial number.

Pump motor make and frame size.

Pump motor horsepower and rpm.

Pump Test Data for Recirculating Pumps in Evaporative Coolers. Use Pump Test report for Cooling Towers (Indicated and Actual Values):

Voltage at each connection.

Amperage for each phase.

Water flow rate in gpm.

Water Test Data (Indicated and Actual Values):

Entering-water temperature in deg F.

Leaving-water temperature in deg F.

SECTION 3: TECHNICAL GUIDELINES

Water temperature differential in deg F.

Entering-water pressure in feet of head or psig.

Leaving-water pressure in feet of head or psig.

Water pressure differential in feet of head or psig.

Water flow rate in gpm.

Bleed water flow rate in gpm.

Air Data (Indicated and Actual Values):

Duct airflow rate in cfm.

Inlet-duct static pressure in inches wg.

Outlet-duct static pressure in inches wg.

Average entering-air, wet-bulb temperature in deg F.

Average leaving-air, wet-bulb temperature in deg F.

Ambient wet-bulb temperature in deg F.

Heat-Exchanger/Converter:

For steam and hot-water heat exchangers and converters.

Unit Data:

Unit identification.

Location.

Service.

Make and type.

Model and serial numbers.

Ratings.

Steam Test Data (Indicated and Actual Values):

Inlet pressure in psig.

Condensate flow rate in lb/h.

Primary Water Test Data (Indicated and Actual Values):

Entering-water temperature in deg F.

Leaving-water temperature in deg F.

Entering-water pressure in feet of head or psig.

Water pressure differential in feet of head or psig.

Water flow rate in gpm.

Secondary Water Test Data (Indicated and Actual Values):

Entering-water temperature in deg F.

Leaving-water temperature in deg F.

Entering-water pressure in feet of head or psig.

Water pressure differential in feet of head or psig.

Water flow rate in gpm.

Pump Test:

Calculate impeller size by plotting the shutoff head on pump curves.

Unit Data:

Unit identification.

Location.

Service.

Make and size.

Model and serial numbers.

Water flow rate in gpm.

Water pressure differential in feet of head or psig.

Required net positive suction head in feet of head or psig.

Pump rpm.

Impeller diameter in inches.

Motor make and frame size.

Motor horsepower and rpm.

Voltage at each connection.

Amperage for each phase.

Full-load amperage and service factor.

Seal type.

Test Data (Indicated and Actual Values):

Static head in feet of head or psig.

Pump shutoff pressure in feet of head or psig.

Actual impeller size in inches.

Full-open flow rate in gpm.

Full-open pressure in feet of head or psig.

Final discharge pressure in feet of head or psig.

Final suction pressure in feet of head or psig.

Final total pressure in feet of head or psig.

Final water flow rate in gpm.

Voltage at each connection.

Amperage for each phase.

Boiler:

Unit Data:

Unit identification.

Location.

Service.

Make and type.

Model and serial numbers.

Fuel type and input in Btuh.

Number of passes.

Ignition type.

Burner-control types.

Voltage at each connection.

Amperage for each phase.

Test Data (Indicated and Actual Values):

Operating pressure in psig.

Operating temperature in deg F.

Entering-water temperature in deg F.

Leaving-water temperature in deg F.

Number of safety valves and sizes in NPS.

Safety valve settings in psig.

High-limit setting in psig.

Operating-control setting.

High-fire set point.

Low-fire set point.

Voltage at each connection.

Amperage for each phase.

Draft fan voltage at each connection.

Draft fan amperage for each phase.

Manifold pressure in psig.

Inspections

Initial Inspection

After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.

Final Inspection

After initial inspection is complete and evidence by random checks verifies that testing and balancing is complete and accurately documented in the final report, request that a final inspection be made by Owner and Engineer.

TAB firm test and balance engineer shall conduct the inspection in the presence of Owner and Engineer.

Engineer shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to 10 percent of the total measurements recorded for each system.

If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as FAILED.

If the number of FAILED measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and the Final Report shall be rejected.

In the event the Final Report is rejected, the TAB firm shall recheck all measurements and make necessary adjustments. The TAB firm shall revise the final report and document balancing device settings to reflect all changes. The TAB firm shall resubmit the report and request another final inspection. Additional work incurred from FAILED test and balance reports shall be at no additional cost to the Owner.

Opposite Season Test

The balancing agency shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

23 21 13 - Hydronic Piping

Revised May 2013

Part 1 – Products

Heating Hot Water (<200F) and Chilled Water Piping

Building and Campus Main Distribution

Copper (2" and smaller)

Pipe: Type L, hard drawn, ASTM B88

Joints: Lead free solder, ASTM B32

Fittings: Wrought copper, ANSI B16.22.

Carbon Steel (2-1/2" and larger)

Pipe: Grade B, Type S (preferred) or E, standard weight, ASTM A53

Joints: Butt welded

Fittings: Carbon steel, standard weight, seamless, ASTM A234 WPB, ANSI B16.9

Direct buried: Pre-insulated pipe system with pipe as described above, polyurethane foam insulation and fiberglass reinforced polyester resin jacket.

Valves

Isolation Valves:

Ball valve, bronze body, full port, stainless steel ball and stem, teflon seat, quarter turn.

Butterfly valve, cast or ductile iron body, lug type, stainless steel stem, aluminum-bronze disc, EPDM seat, quarter turn.

Gate valves shall not be used unless preapproved by ASU.

Balancing Valves:

Globe valve, dezincification resistant brass or bronze, metering ports with position display, multiple turn with memory stop. Quarter turn valves shall not be used.

Butterfly valve with venturi flow meter, ductile iron body, lug type, aluminum bronze disc, EPDM seat, multiple turn with memory stop. Quarter turn valves shall not be used.

Part 2 - Execution

Piping

For changes in horizontal pipe sizes, use eccentric reducer fitting installed with level side up. Concentric fittings may be used in vertical applications.

Install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

Minimum pipe size shall be $\frac{3}{4}$ ".

Valves

Provide separate balancing, check and isolation valves at the discharge of hydronic pumps. Triple duty valves shall not be used. Balancing valves at pump discharge should be sized for a maximum pressure drop of 5 feet at design flow rate (full open) and allow a pressure of 25 feet when throttled. Balancing valves on pumps with VFD's are not desired, however some level of flow measurement at each pump shall be implemented. Check valves shall be located on the equipment side of the isolation valve.

Install shutoff duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

Install balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

Install relief valves as required by code. Install relief-valve discharge piping, without valves, to floor sink.

Specialties

Bypass chemical feeders shall be installed in an upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest floor sink.

Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

Install system air separators at the lowest pressure, highest temperature point in the system.

Terminal Equipment Connections

Size for supply and return piping connections shall not be less than equipment connections.

Install control valves in accessible locations close to connected equipment. Control valves shall be installed in the return piping.

Install ports for pressure and temperature gages at coil inlet connections.

Install balancing valve at each terminal device. Balancing valve shall be installed in the return piping downstream of the control valve.

23 21 23 - Hydronic Pumps

Revised May 2013

Part 1 – Products

Section left blank intentionally.

Part 2 - Execution

General

Install pumps in accordance with manufacturers instructions. Confirm materials of construction against system operating conditions with the manufacturer.

In general, use flat characteristic pumps for closed loop, variable volume systems. Use steep characteristic pumps for open loop, constant volume systems.

Preferred selection of pumps is in the range of 85% to 105% of flow at the best efficiency point. Select pumps slightly to the left of the best efficiency point and such that larger impellers may be installed for future considerations.

Set base mounted pumps on concrete bases, or concrete inertia base, level and bolt down prior to grouting. Fill entire base with non-shrinking grout. Use end caps during grouting to prevent overflow when end caps are not integral with base plates.

Impellers shall be trimmed or replaced if it is shown that the actual system curve produces excessive flow at full load than at the designed system curve.

Motors shall be selected to be non-overloading at the specified impeller size and maximum flow.

Use double suction horizontal or vertical split case pumps for high capacity applications.

Use mechanical seals. Packing type not allowed.

Bearings shall be heavy duty regreasable ball bearings.

Provide necessary concentric reducers/increasers for vertical piping at pump connection and eccentric reducers/increasers for horizontal piping at pump connection. Install eccentric reducers/increasers with top of pipe level. Valves and piping specialties shall be full line size.

Inline Centrifugal (May be used for applications up to 5 hp)

Mount pumps with motors mounted vertically.

Pumps shall be pipeline mounted without flexible connections.

End Suction Centrifugal

Use flexible/split coupled pumps whenever possible. Do not use close coupled pumps over 20 hp. Design shall allow for servicing of impeller and bearing assembly without disturbing piping, motor or requiring shaft realignment.

Align flexible couple pumps after base grouting. Align in all four planes. After alignment, pin pump and motor to base.

Set close coupled pumps on concrete bases using flush type anchors and cap screws.

23 22 13 - STEAM AND CONDENSATE HEATING PIPING
(Excludes Clean Steam)

Revised May 2013

Part 1 – Products

Steam Pipe - 0 to 100 PSIG

Building Distribution:

Carbon Steel (2" and smaller)

Pipe: Grade B, Type S (preferred) or E, standard weight, ASTM A53

Joints: Screwed NPT

Fittings: Malleable iron, ANSI B16.3

Carbon Steel (2-1/2" and larger)

Pipe: Grade B, Type S (preferred) or E, standard weight, ASTM A53

Joints: Butt welded

Fittings: Carbon steel, standard weight, seamless, ASTM A234 WPB, ANSI B16.9

Campus Main Distribution:

Carbon Steel (2" and smaller)

Pipe: Grade B, extra strong, ASTM A106

Joints: Socket weld

Fittings: Forged carbon steel, #3000 ASTM A105 Grade II, ANSI B16.11

Carbon Steel (2-1/2" and larger)

Pipe: Grade B, extra strong, ASTM A106

Joints: Butt welded

Fittings: Carbon steel, extra strong, seamless, ASTM A234 WPB, ANSI B16.9

Direct buried: Pre-insulated double containment piping with carrier pipe as described above, contained within a drainable, dryable, pressure tested, Class A, insulated steel conduit.

Condensate Pipe - 0 to 100 PSIG, Pumped Condensate

Building Distribution:

Carbon Steel (2" and smaller)

Pipe: Grade B, extra strong, ASTM A106

Joints: Screwed NPT

23 22 13 - STEAM AND CONDENSATE HEATING PIPING
(Excludes Clean Steam)

Revised May 2013

SECTION 3: TECHNICAL GUIDELINES

Fittings: Malleable iron, ANSI B16.3

Carbon Steel (2-1/2" and larger)

Pipe: Grade B, extra strong, ASTM A106

Joints: Butt welded

Fittings: Carbon steel, standard weight, seamless, ASTM A234 WPB, ANSI B16.9

Campus Main Distribution:

Carbon Steel (2" and smaller)

Pipe: Grade B, extra strong, ASTM A106

Joints: Socket weld

Fittings: Forged carbon steel, seamless, 3000# ASTM A105 Grade II, ANSI B16.11

Carbon Steel (2-1/2" and larger)

Pipe: Grade B, extra strong, ASTM A106

Joints: Butt welded

Fittings: Carbon steel, extra strong, seamless, ASTM A234 WPB, ANSI B16.9

Direct buried: Pre-insulated double containment piping with carrier pipe as described above, contained within a drainable, dryable, pressure tested, Class A, insulated steel conduit.

Valves

Isolation Valves:

Condensate:

Ball valve, bronze body, full port, stainless steel ball and stem, blowout proof stem, RTFE seat, quarter turn. (1/2" thru 2")

Gate valve, forged carbon steel, 800# ASTM A-105, 12-13% chrome, OS&Y bolted bonnet, renewable seat, solid wedge disc. (1/2" thru 2")

Gate valve, cast carbon steel, 150# ASTM A-216 WCB, 13% chrome to hard facing, OS&Y bolted bonnet, flexible disc. (2-1/2" thru 24")

Steam:

Gate valve, forged carbon steel, 800# ASTM A-105, 12-13% chrome, OS&Y bolted bonnet, renewable seat, solid wedge disc. (1/2" thru 2")

Gate valve, cast carbon steel, 150# ASTM A-216 WCB, 13% chrome to hard facing, OS&Y bolted bonnet, flexible disc. (2-1/2" thru 24")

23 22 13 - STEAM AND CONDENSATE HEATING PIPING
(Excludes Clean Steam)

Throttling Valves (steam):

Globe valve, forged carbon steel, 800# ASTM A-105, 12-13% chrome, OS&Y bolted bonnet, loose seat, integral fard faced seat. (1/2" thru 2")

Globe valve, cast carbon steel, 150# ASTM A-216 WCB, 13% chrome to hard facing, OS&Y bolted bonnet, renewable seat ring and disc. (2-1/2" thru 6")

Check Valves at:

Condensate traps:

Stainless steel body, stainless steel trim, inconel spring, TFE seat. (1/2" thru 2")

Cast steel body, 13% chrome to hard facing, bolted bonnet, renewable disc swing type. (2-1/2" thru 24")

Condensate pump discharge:

Stainless steel body, stainless steel trim and spring, spring loaded type. 1/2" thru 2")

Cast iron, stainless steel trim, spring loaded wafer type. (2-1/2" thru 24")

Part 2 - Execution

Piping

For changes in horizontal pipe sizes, use eccentric reducer fitting installed with level side down. Concentric fittings may be used in vertical applications.

Install steam branch connections to steam mains using 45-degree fittings in main pipe, with the takeoff coming out the top of the main pipe. 45-degree fitting shall be in the direction of flow. Use of 90-degree tee fittings is permissible if 45-degree fittings are impractical. If length of branch takeoff is less than 10 feet, pitch branch line down toward mains at a minimum 0.4 percent grade.

Install condensate branch connections to condensate mains using 45-degree fittings in main pipe with takeoff coming out of the top of the main in the direction. 45-degree fitting shall be in the direction of flow. Use of 90-degree tee fittings is permissible of 45-degree fittings are impractical.

Install condensate connection from steam mains using bottom connection to the main.

Install non-seamless pipe with seam at the top of the pipe.

Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, control valves, isolation valves, pipe bends, and expansion joints.

On straight runs with no natural drainage points, install drip legs at intervals not exceeding 300 feet where pipe is pitched down in direction of steam flow and a maximum of 150 feet where pipe is pitched up in direction of steam flow.

SECTION 3: TECHNICAL GUIDELINES

Size drip legs at vertical risers same size as pipe and extend beyond rise. Size drip legs at other locations same diameter as main. In steam mains NPS 6 and larger, dirt leg size can be reduced, but to no less than NPS 4.

Install gate valve at bottom of drip legs, dirt pockets, and strainer blowdowns to allow removal of dirt and scale.

Install steam traps close to drip legs.

Steam Line Drainage: For steam pipes in tunnels sloped down in the direction of steam flow; a minimum of three inches per one-hundred feet (3" per 100') of length is required. Where counter-flow of condensate must be accommodated in steam tunnels, lines shall be pitched up in the direction of steam flow six inches per one-hundred (6" per 100') feet of length. Buried steam lines shall be pitched to accommodate the worst case of 6" per 100 feet. Steam lines may be peaked with lines pitched as above. Final pipe elevations must be recorded on the as-built drawings.

Valves

Install check valve at steam condensate trap discharge if condensate is to be lifted. Install check valve between trap discharge and isolation valve. Layout and install pipe to minimize the lifting of condensate to the greatest extent possible.

Install check valve in each pump discharge line.

Install manually regulated bypass valves around control valves at main building heat exchangers and each pressure reducing station. The bypass valve shall be equal in capacity to the control valve or PRV. Where an array of control valves or PRV's are used, i.e. 1/3 – 2/3 control strategies, the bypass shall be equal in capacity to the largest valve in the array.

Specialties

Install steam traps on the discharge side of all steam using terminal apparatus, at steam headers, at steam mains, at end of steam mains, at end of branch piping exceeding 10 ft, at points where steam piping must rise, and elsewhere as required.

Install steam traps in accessible locations as close as possible to connected equipment, but not more than 48 inches from connected equipment.

Use float and thermostatic traps at heat exchangers.

Drip traps: Generally, use float and thermostatic or inverted bucket traps for systems 30 PSIG or less and thermodynamic or inverted bucket traps for systems over 30 PSIG.

23 22 23 - Steam Condensate Pumps

Revised May 2013

Part 1 – Products

Pumps shall be cast iron, bronze fitted with mechanical shaft seals.

Receiver shall be heavy-duty cast iron with tappings for pump suction, condensate inlet, vent, drain, overflow and float control assembly.

Receiver shall have gauge glass and thermometer tappings and water level gauge and thermometer.

Pumps shall be duplex with lead-lag operation.

Part 2 – Execution

Connect to standby power. Provide high water limit alarm locally and at ASU BAS.

Vent through roof separate from the building vent.

23 23 00 - Refrigerant Piping

Revised May 2013

Part 1 – Products

Copper

Pipe: Type L, hard drawn, ASTM B88, dehydrated, cleaned and capped, ASTM B280, marked ACR.

Joints: Brazed, AWS A5.8, BCuP-5

Fittings: Wrought copper, ANSI B16.22.

Part 2 – Execution

Install refrigerant lines in a manner so that the velocity in the evaporator suction line will move the oil and gas to the compressor. Oils shall be automatically returned on halocarbon systems. If vertical risers are required, provide riser of a size so that the oil will be lifted at minimum system loading and corresponding reduction of gas volume. Provide double risers if the excessive velocity and pressure drop exist.

Copper tubing/pipe shall be filled with nitrogen during the brazing process.

Slope:

Horizontal hot gas discharge 1/2" per 10 feet downward away from compressor.

Horizontal suction lines 1/2" per 10 feet downward to the compressor. Do not create a situation where oil can separate from the suction gas and return to the compressor in slugs.

Liquid lines may be installed level.

Insulate suction lines and hot gas bypasses if used.

23 31 00 - Hvac Ducts And Casings

Revised May 2013

Section 23 31 00 is for general HVAC applications only. Other materials, design and construction considerations shall be evaluated and proposed for special systems, such as laboratory and industrial exhaust systems. Consult with ASU FDM and EH&S.

Part 1 – Products

Galvanized Sheet Steel

Lock-forming quality; capable of double seaming without fracture, complying with ASTM A653 or A924 and having G90 coating; ducts shall have mill-phosphatized finish for surfaces exposed to view.

Part 2 – Execution

General

Pressure class for VAV systems shall be equal to the static pressure at the discharge of the supply fan but not less than 4" WG positive. Pressure class downstream of the air terminal unit shall not be less than 2" WG positive. Pressure class for ductwork on suction side of the AHU and/or suction side of return fan shall be equal to static pressure at inlet of return fan but not less than 2" WG negative.

Pressure class for constant air volume system ductwork shall be equal to the external static pressure of the air handling equipment, but not less than 2" WG positive or negative.

Heat gain/loss, first cost and operating costs are affected by duct aspect ratio. Try to limit rectangular ducts to an aspect ratio of no larger than 4:1 (ratio of long side to the short side). For this reason, round duct is preferred over rectangular duct.

Seal duct seams and joints to meet SMACNA Class A for all ductwork. Leakage class for metal/non-flexible ducts shall be 3 for round and flat oval and 6 for rectangular.

Internal tie rods or bracing shall not be used for ductwork 36" or smaller. (Where noise may be a concern.)

Internal tie rods are not allowed for welded duct systems and special exhaust systems.

Install duct free of kinks, sags and dents.

Duct liner is prohibited.

Fiber board duct is prohibited.

Exterior rectangular duct (or insulation) shall be pitched to prevent ponding.

Flexible Duct

Flexible duct may be used for duct connections to air inlets and outlets for sound attenuation purposes. Duct shall not exceed 7 feet in length.

SECTION 3: TECHNICAL GUIDELINES

Flexible duct shall not be used in inaccessible locations, over hardlid ceilings or penetrate walls or floors.

Flexible duct shall not be used on high pressure ductwork (3" WG and over or special exhaust systems).

Elbows

Rectangular, round and flat-oval duct, unvaned radius elbows with minimum centerline radius equal to 1.5 of the duct width are preferred. Use 1.0 radius elbows where 1.5 radius elbows to not fit.

Rectangular duct where 1.5 radius elbows to not fit:

Supply:

Use 1.0 radius elbows or square throat elbows with turning vanes.

Return:

Use 1.0 radius elbows with splitter vanes or 45° throat with radius heel elbows with turning vanes.

Square throat – radius heel elbows or square throat elbows with turning vanes shall not be used.

Exhaust: Turning vanes are prohibited.

Duct Transitions

Duct area should not be reduced more than 20% to avoid an obstruction.

When a duct transition with a constant area is to be used, a slope of 1 inch in 7 inches length is desirable. If this slope cannot be maintained for low velocity ducts, a slope not to exceed 1 inch in 4 inch length can be used.

For transitions where different size or different shape ductwork segments are connected, use concentric transitions unless otherwise shown. Unless otherwise indicated, make diverging transitions with maximum angle of 15° per side (30° total diverging) and converging transitions with maximum angle of 22.5° per side (45° total converging).

If reductions in area are required in main duct, the transformation should be located at or after a branch takeoff. Whether or not a reduction is required depends upon the air flow volume in the main and the air flow volume in the branch.

Limit reductions in rectangular duct to one dimension per transition.

Branch Duct or Terminal Take-Off

Full radius elbows should be used for large branch take-offs from rectangular mains. The areas of the branch and main duct should be proportioned based upon the air volume requirements for each duct.

Conical 90° tees, or 45° lateral tees followed by 45° elbows, should be used for round ducts.

Design of rectangular branch duct take-offs should consider air velocity, static pressure, and the ratio of branch air flow to main air flow.

Rectangular Duct Longitudinal Seams

Unless specified otherwise, use Pittsburgh lock seam.

23 33 00 - Air Duct Accessories

Revised May 2013

Section 23 33 00 is for general HVAC applications only. Other materials, design and construction considerations shall be evaluated and proposed for special systems, such as laboratory and industrial exhaust systems. Consult with ASU FDM and EH&S.

Part 1 – Products

Flexible Connections

Neoprene coated glass fabric, fire retardant, waterproof, air tight, UV resistant (outdoor use) and comply with UL 214 and NFPA 90A.

Manual Balancing Dampers

Dampers shall be selected and properly constructed to prevent vibration, flutter or other noise.

Provide with locking quadrants and position indicators.

Sheetmetal screws are not allowed in construction of damper.

Part 2 – Execution

Fire/Smoke Dampers

Duct systems shall be carefully laid out to minimize the number of fire, smoke and fire-smoke dampers.

Manual Balancing Dampers

Provide balancing dampers to each diffuser and grille and elsewhere to facilitate system balancing. Dampers located at the face and neck of diffusers shall not be used in noise sensitive areas and should only be considered in hard lid areas.

Install dampers as close as possible to take-offs in a readily accessible location. Dampers shall be in the same room as the diffuser whenever possible with the damper handle clearly identifiable.

Splitter dampers and diverters shall not be used.

Access Doors

Provide access doors anywhere that maintenance, service, cleaning or examination is required, including automatic dampers, fire damper, smoke damper, smoke detector, fan bearing, coils, humidifier, filter, bird/insect screen, valve within duct or casing, outside air intake duct and at inlet side of turning vanes in return ductwork.

Flexible Connections

Provide flexible connections between ductwork and fans or equipment subject to vibration that is not internally isolated. Width shall be suitable for application but shall not be less than 4"

Pressure Relief Doors

Where the duct pressure class is not designated to accommodate the fan shut off head, provide pressure relief doors to open automatically to relieve excess pressure (both positive and negative) in ductwork where the fan static pressure could exceed duct pressure class and could damage ductwork. Also provide where fan motor VFD's are provided with a means to operate in bypass mode.

23 34 00 - Hvac Fans

Revised May 2013

Part 1 – Products

Fans shall be tested and certified in accordance AMCA 211 and bear the AMCA seal.

Each fan shall be statically and dynamically balanced to grade G6.3 per ANSI S2.19. Complete fan assembly shall be factory statically and dynamically balanced to meet BV-3 (minimum) per the latest AMCA 204-XX “Balance Quality and Vibration Levels for Fans”.

Direct drive fans are preferred over belt driven fans. For belt driven fans, furnish fans with V-belt drives with fixed-pitch sheaves. System air balancing shall be accomplished by either trial of different fixed-pitch sheaves or use of temporary adjustable-pitch sheaves. V-belts shall be rated for 150% of motor nameplate horsepower. For critical fan applications, provide V-belt drives at 200% of motor nameplate horsepower. A metal tag showing manufacturers model number, size and style of replacement belt set shall be attached to each belt guard. Provided with adjustment capability for tension and alignment. Multiple belts shall be factory matched sets.

For centrifugal, belt driven, non-plenum fans, arrangement 10 is preferred over arrangement 1, arrangement 1 is preferred over 9. Arrangements will vary depending on fan type and use.

Plenum fan arrangement 4 is preferred over arrangement 1, arrangement 1 is preferred over arrangement 3.

Each fan and motor combination shall be capable of delivering 110% of air quantity scheduled at the scheduled static pressure and the motor shall not operate into motor service factor.

Bearings shall be heavy duty, grease lubricated, pillow block, self-aligning ball or roller. Minimum life shall be 80,000 hours at ABMA-L10. Extend fittings to outside of drive.

Exhaust fans shall be provided with means of drainage.

Part 2 – Execution

Fans shall be selected based on total static pressure to best minimize energy consumption.

Limit inlet and outlet duct configurations that increase system static pressure due to system effect factors. Refer to AMCA 201. Where unavoidable, such factors shall be considered when selecting the fan.

Include drive losses in motor selection.

Select fan to operate at a single stable operating point. Fans having 2 potential operating points on the fan curve are not acceptable. Forward curved fans should be avoided for this reason.

Fans shall not be selected where the operating range of the system subjects the fan to operate under stall or surge conditions.

Exhaust fan discharge shall comply with code and recognized standards, but shall not be less than 7'-0" above finished roof, with the exception of general/relief or toilet exhaust systems.

23 36 00 - Air Terminal Units

Revised May 2013

Part 1 – Products

Units shall be pressure independent.

Control panels shall be mounted on the same side of the reheat coil piping.

Units performance shall be certified in accordance with AHRI Standard 880.

Provide access panels upstream of coils.

Units shall be sealed to meet allowable leakage rates specified for low pressure ductwork.

Part 2 – Execution

Provide a minimum of 24" clearance in front of the unit controller. Coordinate with code required minimum clearances. Keep this clearance space unobstructed from below to maintain a path to this access space.

Maintain clearance to maintainable components, such as access panels, actuators, etc.

Minimum flow rates shall maintain the code required minimum ventilation rates when the spaces served are occupied.

Select terminal units to have at least 10 percent additional capacity of the outlets/inlets served for future considerations. The selections shall consider operating characteristics such as noise and pressure drop. The selection shall not cause the units to hunt.

In general, the selected unit's maximum airflow should not exceed 75% of the rated capacity, and the minimum airflow should not be less than 20% of the rated capacity. Adjust as necessary with manufacturer's written instruction.

Flexible duct shall not be connected directly to air terminal units inlets. Provide straight length of hard duct at air terminal units. Coordinate the required straight length with the manufacturer's instructions to optimize performance. The use of flow straightening devices are prohibited unless approved by variance.

24V transformers shall be mounted individually at each terminal unit controller. Provide 120V power to the controller transformer.

Refer to Division 25 - VAV Terminal Unit Controller (VAV) for additional requirements.

23 37 00 - Air Outlets And Inlets

Revised May 2013

Part 1 – Products

General

Outlets and inlets shall be steel or aluminum and have baked enamel finish for standard air comfort applications uses. Other materials and finishes for aggressive environments shall be evaluated on a case-by-case basis.

Diffusers

Provide equalizing grids and pattern controllers as necessary of the application and installation.

Registers and Grilles

Supply registers and grilles shall be double deflection type with adjustable horizontal and vertical control.

Return and exhaust registers and grilles shall have fixed blade cores.

Fabric duct sock ducts and diffusers may be allowed by variance only.

Part 2 – Execution

Many factors affect inlet and outlet selection and placement, including ceiling height, design temperatures, distribution system strategies, etc. Inlets and outlets shall be selected and laid out to best perform under these differing conditions to maximize space comfort, adequately distribute ventilation air and/or provide containment, makeup air and process control.

Overhead mixing systems shall be designed and laid out to achieve a minimum ADPI of 80%.

Outlets shall be selected to maximize performance under the full range of airflow for the space served. Outlet performance shall be evaluated at both minimum and maximum flow conditions.

Inlets and outlets shall be covered during construction before system startup to protect distribution and equipment from dirt, dust and debris.

23 40 00 - Hvac Air Cleaning Devices*Revised May 2013***Part 1 – Products**

Coordinate the preferred manufacturer and model with ASU FM for each campus.

Size filter racks to receive one or more of ASU stock sizes:

ASU STOCK #	SIZE	DESCRIPTION
85133000	14 X 24 X 1 Pinch Frame	Filter Throw Away Frame Media
85133200	14 X 25 X 1 Pinch Frame	Filter Throw Away Frame Media
85133400	14 X 30 X 1 Pinch Frame	Filter Throw Away Frame Media
85133600	16 X 20 X 1 Pinch Frame	Filter Throw Away Frame Media
85133800	16 X 25 X 1 Pinch Frame	Filter Throw Away Frame Media
95134000	18 X 24 X 1 Fiberglass	Filter Throw Away Frame Media
85134100	18 X 20 X 1 Fiberglass	Filter Throw Away Frame Media
85134200	18 X 25 X 1 Pinch Frame	Filter Throw Away Frame Media
85134400	18 X 30 X 1 Fiberglass	Filter Throw Away Frame Media
85134600	20 X 20 X 1 Pinch Frame	Filter Throw Away Frame Media
85134800	20 X 25 X 1 Pinch Frame	Filter Throw Away Frame Media
85135000	20 X 30 X 1 Pinch Frame	Filter Throw Away Frame Media
85135050	22 X 27 X 1 Fiberglass	Filter Throw Away Frame Media
85135500	24 X 24 X 1 Pinch Frame	Filter Throw Away Frame Media
85136000	12 X 24 X 2 C Series	Filter Pleated Panel
85136500	12 X 24 X 4 C Series	Filter Pleated Panel
85140000	15 X 20 X 2 Fiberglass	Filter Throw Away Frame Media
85158200	16 X 20 X 2 35-40 Nb C Series	Filter Pleated Panel
85158300	16 X 24 X 1 7/8 C Series	Filter Pleated Panel
85158400	16 X 25 X 2 35-40 Nbs C Series	Filter Pleated Panel

SECTION 3: TECHNICAL GUIDELINES

ASU STOCK #	SIZE	DESCRIPTION
85158500	18 X 24 X 2 35-40 Nbs C Series	Filter Pleated Panel
85158550	18 X 24 X 4 E-35 C Series	Filter Pleated Panel
85158575	20 X 20 X 1 C Series	Filter Pleated Panel
85158600	20 X 20 X 2 35-40 Nbs C Series	Filter Pleated Panel
85158650	24 X 24 X 2 E Series 55%	Filter Pleated Panel
85158700	20 X 20 X 4 C Series	Filter Pleated Panel
85158800	20 X 25 X 2 C Series	Filter Pleated Panel
85158900	20 X 25 X 4 C Series	Filter Pleated Panel
85159000	24 X 24 X 2 C Series	Filter Pleated Panel
85161400	10 X 1 X 85	Filter Media
85161600	12 X 1 X 85	Filter Media
85161900	24 X 24 X 4 C Series	Filter Pleated Panel

Part 2 – Execution

Noncentral air handling systems shall be equipped with replaceable filters with a 25% minimum dust spot efficiency (30% nominal efficiency, 96% arrestance) and a minimum reporting value of MERV 8.

Central air handling systems shall be equipped with replaceable pre-filters with a 25% minimum dust spot efficiency (30% nominal efficiency, 96% arrestance) and a minimum reporting value of MERV 8.

Central air handling systems shall be equipped with replaceable final-filters with a 80% minimum dust spot efficiency (85% nominal efficiency, 98% arrestance) and a minimum reporting value of MERV 13.

Filter frames shall be suitable for the velocity and differential pressure of the application to maintain an airtight seal from initial through final resistance. Frames shall be provided with gaskets and latching devices. Prefilter and final filters shall be installed in separate frames which allow the final filters to be replaced without having to remove the prefilters.

All air shall be filtered during construction.

Construction filters shall be replaced during construction as needed to protect the the equipment. Construction filters shall be replaced at the time the Owner accepts the building as complete.

SECTION 3: TECHNICAL GUIDELINES

Pre and final filter maximum face velocity shall be 500 fpm.

23 52 00 - Heating Boilers

Revised May 2013

The design professional shall consult with ASU FM and ASU CPMG Mechanical Engineer for boiler and feedwater selections.

Boiler safety controls and trim shall conform to Factory Mutual (FM) requirements and inspections certificates furnished. Each boiler shall be UL listed and must display the UL listing label on the boiler showing the unit approved as a complete package boiler assembly.

23 60 00 - Central Cooling Equipment

Revised May 2013

The design professional shall consult with ASU FM and ASU CPMG Mechanical Engineer for chiller and cooling tower selection.

23 73 00 - Air Handling Units

Revised May 2013

This section is intended for custom central air handling units. Packaged and semi-custom units shall incorporate the intent of these elements as is intended for a durable, efficient, maintainable and low leakage unit.

Part 1 – Products

Base

Fully welded structural steel or fabricated steel.

Floor

Constructed and sealed to meet maximum deflection and leakage requirements. Floor shall be welded to the unit base. Drive screws are not allowed. Use tread plate or finish with anti-slip epoxy.

Floor, including integral recessed drain pans where used, shall be externally insulated to match unit housing performance and covered with a painted or galvanized liner. Design shall prevent condensation on exterior surface and provide a continuous vapor barrier at the liner.

Housing

4" double wall panel construction with internal support spaced to meet maximum deflection requirements. Minimum 2" double wall panel construction may be used for interior units located within conditioned spaces as long as performance requirements are met.

Bolted construction preferred. Joints and seams shall be sealed to meet leakage rate.

Exterior construction:

Minimum 16 ga G-90 galvanized steel, primed and painted.

Interior construction:

All sections shall have solid inner surface faces.

Minimum 20 ga G-90 galvanized steel.

Minimum 18 ga stainless steel at cooling coil section and access section downstream of coil to fan inlet.

Insulation for exterior/unconditioned space installations shall have a maximum U-value of 0.06 Btu/hr ft² °F. Interior units installed in conditioned space shall have a maximum U-value of 0.12 Btu/hr ft² °F.

Incorporate thermal break construction to prevent condensation on the outside surface of the unit casing where units are installed in exterior and/or unconditioned space. Thermal break calculations shall be submitted to for review and approval as part of Shop Drawings.

Provide blank off panels to prevent air bypass around equipment.

Exterior installation roofs shall be standing seam, water tight, pitched a minimum of 1/4" per foot.

Access

Doors shall be of same construction as housing panels. Each door shall have a 12x12 double paned window.

The door frame shall be one piece with high performance knife-edge and replaceable neoprene gasket seal.

Doors shall have similar thermal break as housing.

Doors shall open against pressure. Preferred minimum door width is 24". Coordinate door width with equipment removal requirements. Provide removeable panels as required. Height shall be 72". If unit is shorter than 72", minimum height shall be 48".

Provide platform and steps at doors for outdoor units installed 24" above finished roof level.

Provide latches similar to Ventlok 260.

Cooling Coil Section

Support coils by stainless steel frame independent of unit casing. Blank off panels shall be stainless steel.

Each coil bank shall include minimum 16 ga stainless steel all welded, double sloped condensate drain pans. Provide intermediate drain pans where coils are stacked. Condensate drain pans shall have sufficient depth to hold condensate and shall be a minimum of 2" deep. Drain pans shall extend a sufficient length upstream and downstream of the coil to collect condensate, but no less than 12" downstream of the coil and 4" upstream.

Coil sections shall have tracks that extended the full width of the unit and depth of coils to provide easy removal of service and maintenance.

Fans and Motors

Plenum/plug type with airfoil blades, arrangement 4 are preferred.

Flexible connections to fan inlets shall be fastened with sheet metal screws. Clips are not allowed.

Provide overhead track or eye bolts to aid in the removal of fans. Track should be used for fan motors 25hp or over.

Control Dampers

Dampers shall AMCA Standard 500 certified low leakage dampers.

Damper frames shall be extruded aluminum. Outside air damper frames shall be insulated on all sides.

Blades shall be extruded aluminum airfoil shaped, double skin construction. Outside air dampers shall be internally insulated.

Provide multiple dampers to minimize racking and binding. Maximum damper section shall be 48" x 48". Provide stiffeners between damper sections for maximum rigidity.

Damper blade axles shall be hexagonal steel and provide positive locking connection to blades and linkage.

SECTION 3: TECHNICAL GUIDELINES

All linkage must be exposed to insure easy accessibility for adjustment and maintenance. Linkage shall be factory set-up for smooth damper operation. Damper operation shall be factory tested.

Damper leakage for a 48" x 48" damper shall not exceed AMCA 500 Class 1 rating at 4" WG pressure difference.

Pressure drop for a 48" x 48" damper shall not exceed .05" WG at 1,000 fpm full open.

Provide individual actuators for each section of control dampers. Size actuators to operate with sufficient reserve power to provide smooth modulating action or 2-position action.

Electrical

Each access section shall be provided with a minimum of one light. Number of lights shall be sufficient to allow for adequate inspection and maintenance. LED lights are preferred.

Provide convenience outlets at fan section(s), both inside and outside the unit.

Part 2 – Execution

Units shall be in a draw thru arrangement with the supply fan downstream of the cooling coil.

Provide diffuser section to distribute fan discharge air evenly over unit as necessary.

Factory leak test full assembly. Leakage shall not exceed 1% at 1.5 times the operating pressure, or 10" WG whichever is less.

Factory test full assembly. Maximum allowable deflection shall not exceed 1/200th of any span in any direction at minimum 10" WG (positive for discharge side of fan and negative for suction side of fan) or supply fan design static discharge pressure, whichever is higher.

Outdoor air handlers: VFD mounted at the air handler shall be accessible from outside the air handler. When VFD's are cooled by air from the air handler, do not use air that could cause condensing at the VFD.

VFD frequency at design conditions shall be limited to 60 Hz maximum.

Field mounting of any equipment on housing walls or roof is not allowed. Field mounting of services that will restrict access to the unit service sections is prohibited.

Silencers or attenuators may be used to meet noise criteria, however they shall not increase the fan total static pressure.

Motor sizes in excess of 40 horsepower shall be preapproved by ASU.

Intake louver maximum face velocity shall be 500 fpm through the net free area.

23 82 16 - Air Coils

Revised May 2013

This section is intended for coils in packaged, semi-custon and custom air handling units. Velocity requirements are for all coils.

Part 1 - Products

Chilled Water Coils

Coils shall be constructed with 5/8" O.D. seamless hard copper tube. Tubes shall have a minimum wall thickness of .035", pitched in the casing to the headers for proper drainage. Provide with turbulence enhancers where required to improve capacities at low flow.

Coils fins shall be continuous plate fin. Maximum fin spacing shall be 10 fins per inch.

No coil shall have more than 8 rows depth.

Casings shall be minimum 16 gauge galvanized steel with allowance for expansion and contraction. Use stainless steel casings for 100% outdoor air units.

Coils over 42" in length shall have steel center support. Coils over 96" in length shall have two tube supports.

Coil assembly shall have provisions to facilitate total removal from coil bank.

Hot Water Coils

Coils shall be constructed with 5/8" O.D. seamless hard copper tube. Tubes shall have a minimum wall thickness of .035", pitched in the casing to the headers for proper drainage. Provide with turbulence enhancers where required to improve capacities at low flow.

Coils fins shall be continuous plate fin or serpentine.

Casings shall be minimum 16 gauge galvanized steel with allowance for expansion and contraction.

Coils over 42" in length shall have steel center support. Coils over 96" in length shall have two tube supports.

Coil assembly shall have provisions to facilitate total removal from coil bank.

Part 2 - Execution

Offset coils as required to allow for removal. Coils should be piped in counterflow arrangement.

Cooling coil selection: Minimum coil dT shall at least be that of the plant designed dT or higher. Supply water temperature should at least be 1°F higher than design inlet water temperature to account for coil fouling.

Coil ends shall have removable casing panels. Coils shall have air vents that are automatic and that extend out of the casing so that they are accessible.

Each coil shall be provided with fittings and valved to allow for mechanical flushing of coils in reverse direction. Provide drain for flushing at low end of coil connections. Provide 3/4 inch

SECTION 3: TECHNICAL GUIDELINES

flush tees on supply and return. All coils shall have isolation valves installed on both supply and return.

Coils shall be selected with a minimum velocity of 3 fps.

Coil maximum face velocity shall be:

Cooling coil face velocity	450 fpm
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Heating coil face velocity	600 fpm
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Preferred water-side and air-side pressure drops shall not exceed 10 feet and 0.75" WC respectively.

DIVISION 25 - INTEGRATED AUTOMATION

25 36 00 - The ASU Energy Information System (Eis)

Revised May 2013

PART 1: Process Guidelines

- A. All issues and concerns regarding ASU's Energy Information System (EIS) should be directed to the Supervisor of ASU's Fire Systems and Support Technologies group, a division of ASU's Facilities Management.
- B. Stakeholders of the EIS include, but are not limited to, ASU Facilities Management, CPMG and the Global Institute of Sustainability.
- C. All metering outlined in this document is intended to accurately report back and update ASU's Energy Information System and Campus Metabolism™ applications.

PART 2: Design Guidelines

- A. Definitions
 - 1. Energy Information System (EIS): An entire system of meters, hardware, software, and communication protocols that are specifically designed to collect energy data from various sources. At the core, an EIS includes a centrally managed data collection server that collects data in 1 min intervals and then stores that data in 15min averages for long term storage. Data exists since their initial connection. The EIS system also includes a front end web interface whereby remote users can access, view and trend any and all data that is collected. All associated network routers, switches, fiber, wiring, as well as open system ports, and open protocol bus or integrators are part of this system and the way it communicates.
 - 2. Campus Metabolism™ is an interactive web tool that enables the user to view the current resource use on campus. One can easily choose to view information by individual building, building type, or the entire campus at different time scales. Campus Metabolism™ was created to highlight the often overlooked and hidden connection between the impact of the actions in our daily lives and the natural world. We hope that this system will be used for learning, teaching, researching and empowering change.
 - 3. Control Wiring: Includes conduit, wire and wiring devices to install a complete Control System including system meters. It also includes all wiring from a SCADA cabinet to all sensors and points defined in this document. Also includes all necessary power wiring to all EIS devices and cabinets.

SECTION 3: TECHNICAL GUIDELINES

4. SCADA: Supervisory Control and Data Acquisition. A SCADA unit is a PLC type device designed to collect data points from a variety of sources. It allows for a decentralized collection process whereby data can be collected and stored independent of a central computer. The control system is built up of stand-alone SCADA units. For the purposes of ASU EIS system, the SCADAPAK from Schneider Electric is the preferred SCADA unit.
(<http://www.controlmicrosystems.com/>)
5. Network: A system of distributed control units that are linked together on a communication highway. A network allows sharing of point information between all control units. Additionally, a network provides central monitoring and control of the entire system from any distributed control unit location.
6. The term “provide” means “provide complete in place”, that is, furnished and installed and ready for operation and use.

B. System Intent

1. The campus Energy Information System and all components of the system is intended to quantify campus energy consumption at various levels of distribution, record all data at 1 minute intervals (15 min for long term storage), and provide a simple method of data retrieval for energy use evaluation. Quantification of consumption is typically achieved at the building level by metering the all utilities being supplied at the building utility entrance. This may include, but is not limited to; electrical, chilled water, steam/hot water, and natural gas. The system is installed to be utilized as a tool to prevent unnecessary energy usage, identify opportunities for reduction of energy consumption, provide analytical information for planning and development of the ASU infrastructure, and assist in achieving ASU’s energy goals.

C. When to Install Metering

1. All new building projects on any ASU campus or ASU owned property shall be required to have EIS metering installed.
2. Any TI that adds additional utility service entrance sections that are above and beyond what is already in place and is currently being metered needs to be metered.
3. Any onsite energy generation station that is attached to the load side of the building shall be metered independently. In the case of solar PV, if the installation is capable of producing more than the building consumes at any given time, the building service entrance meter shall be replaced with a bi-directional meter.
4. Any improvement made external to a building that is not intended to directly service building operation or function, yet receives utilities from the building, shall be metered independently. An example of this would be a cellular tower installed on a building.
5. Any renovation that impacts 50% or more of a non-metered building shall require the addition of metering for the utility entrance sections of the entire building.
 - a. If the cost of metering totals 20% or more of the total construction cost of the renovation, a variance may be submitted to the ASU AHJ.

D. EIS at each ASU Campus

1. A SCADA unit shall be installed as follows:
 - a. The location of this unit shall be installed in the main equipment room of the building. Exceptions must be submitted and approved in writing by the Supervisor of ASU's Fire Systems and Support Technologies group.
 - b. Any and all metering for that building will bring its lines of communications back to this SCADA unit through a hard-wired connection
 - c. If a SCADA unit is unavailable, or if pathway of getting the meter data to the SCADA is impossible to define, only then may an alternative use of a Gateway device be considered.
 - d. The SCADA unit shall, at a minimum, communicate the following protocols:
 - i. HART
 - ii. Discrete Binary Inputs
 - iii. Modbus TCP
 - iv. TCP/IP
2. The communications standard between meters and the SCADA unit shall be done through the use of a MODBUS Serial (RS485) connection.
 - a. For all Modbus Serial communications, the cabling shall be 18 gauge Belden shielded twisted pair (STP), installed in a LOOP configuration.
 - b. The Modbus Serial communications loop will always begin and end at the SCADA unit, without exception. One end will be landed on the SCADA units Modbus serial communications terminals and the other shall be coiled in the panel and each wire of the twisted pair terminated independently with a wire nut. The intent of the Modbus cable returning to the panel is to provide a redundant communication path to the meters or devices.
3. If BACNET communications are required, written approval from ASU's Fire Systems and Support Technologies Supervisor is required. With that, in order to accomplish this, a JACE or some other Fieldserver/Gateway device will be required to translate the BACNET data to Modbus TCP.
4. HART and Binary inputs are also acceptable and must be installed as accordingly to their manufacture recommendations.
5. All SCADA units, meters and devices must communicate back to ASU's centralized servers hosted by ASU's Fire Systems and Support Technologies Department. Data from these devices and meters shall be programmed through and displayed on ASU's Energy Information System and Campus Metabolism™ system.
 - a. Please contact the FSST Supervisor with directions on how to have these systems programmed through.

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6. Updates of the data to ASU's servers will occur as fast as the communication trunks will allow. Data will then be written to the database every minute for the 1st hour and then rolled up to 15 minute averages for long term storage.
7. Upon the completion of the installation of all meters and devices, verification and certification needs to occur regarding the accuracy of the data that is being metered all the way through to the front end. Formal documentation needs to be presented and submitted to ASU detailing the validity of the meters. All meters shall be utility grade and within 1% accuracy.
8. Communications for all SCADA units back to the servers shall reside on ASU's Building Controls VLAN, a secure network residing on the backbone of ASU Network infrastructure. Please contact ASU's FSST Supervisor for more details.
 - a. The protocol of choice for these communications is MODBUS TCP.
 - b. For the Tempe campus ONLY, all EIS data must reside on ASU's dedicated EIS Fiber network.
 - i. If the EIS fiber does not already exist in the building, it must be installed as part of the project.
 - (a) The fiber needs to be installed back a central fiber hub building identified by ASU's FSST Supervisor.
 - (b) The fiber shall be 12 strand Multi-Mode 50 micron.
 - (c) Any exposed fiber shall be run in Blue Inner-Duct to protect the fiber. No other cabling can be run in this inner duct.
 - c. If an exception from the use of fiber is required, express written approval must be granted by ASU's FSST supervisor.
 - i. If approved, only then is the use of ASU's Building Controls VLAN is permissible.

E. Startup

- a. Upon completion of any meter installation, the contractor shall be responsible in verifying the accuracy of the installed meter.
 - i. The meter shall perform within manufacture design specifications
 - ii. Written documentation shall be provided to ASU outlining the accuracy of the meter and results of the tests performed.
- b. A one-line diagram showing how the metering was installed as well as labeling important features (such as Modbus ID's) shall be provided at time of commissioning.

PART 3: Technical Guidelines

A. Electric Metering

1. All Electric metering shall use the Veris meter (<http://www.veris.com>)

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- a. Electric metering on all ASU campuses shall be of utility grade.
- b. All communications shall be either Modbus Serial or, if available, Modbus TCP.
- c. For standard electric metering, the H8036 Modbus Serial CT meter, which is the enhanced meter, shall be used.
- d. When local display at the SES is required as well as Modbus communications, the H84xx Performance Panel with corresponding CT's is required. This panel will also tie on to the existing Modbus serial loop for communications.
- e. The meter shall be installed on the load side of the SES before any distribution of the power.
- f. The metering needs to be installed with the full intent to capture what is being consumed. For example, if the goal is to capture the load of the building, metering at each Service Entrance Section (SES) before any distribution of power needs to occur.
- g. At a minimum, the data provided from the meter shall be instantaneous kW, kWh, Volts per phase, line to neutral per phase, Amps per phase, kVAR, and power factor.
- h. Modbus addressing for the Veris meter dip switches shall start at 7 and proceed from there chronologically on each Modbus serial loop.
- i. All necessary cables, conduit and wire shall be labeled appropriately.

B. Chilled and Hot water metering

1. All Chilled and Hot water metering for the ASU EIS system shall use the Siemens Sitrans F Ultrasonic clamp-on meter (<http://www.automation.siemens.com/w1/automation-technology-clamp-on-flow-18668.htm>)
 - a. All Chilled and Hot water metering on all ASU campuses shall be of utility grade.
 - b. All communications shall be either Modbus Serial or, if available, Modbus TCP.
 - c. The meter shall be installed to manufacture's specifications.
 - d. If current runs of pipe do not meet manufacture recommendations on how the meter shall be installed, then new pipe may be required to be installed to accommodate.
 - e. The metering needs to be installed with the full intent to capture what is being consumed. For example, if the goal is to capture the load of the building, metering at the building entrance needs to occur.

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- f. At a minimum, the data provided from the meter shall be Supply Temperature (Fahrenheit), Return Temperature (Fahrenheit), Flow (in Gallons per Minute) and instantaneous kBTU's.
- g. Modbus addressing for the Siemens meter shall start at 1 and proceed from there chronologically to 6 on each Modbus serial loop.
- h. All necessary cables, conduit and wire shall be labeled appropriately.

C. Steam Metering

- 1. All Steam metering shall use the Siemens Sitrans FX300 flow meter.
(<http://www.automation.siemens.com/w1/automation-technology-sitrans-fx300-18683.htm>)
 - a. Steam metering on all ASU campuses shall be utility grade.
 - b. Communications for this meter is currently HART which is acceptable. If Modbus Serial or TCP are available at a later date, these forms of communications are preferred.
 - c. The meter shall be installed to manufacture's specifications.
 - d. The preference is for the use of a vortex style meter; however, orifice plate styles are also accepted depending on use and written approval of ASU's FSST supervisor.
 - e. Steam meter size calculations shall be provided by the project engineer with final acceptance and approval of ASU.
 - f. At a minimum, the data provided from the meter shall be Supply Temp (Fahrenheit), Pressure (psig), Flow (lb/hr) and instantaneous kBTU's. If possible, temperature of the condensate return is also desired.
 - g. If current runs of pipe do not meet manufacture recommendations on how the meter shall be installed, then new pipe shall be required to be installed to accommodate.
 - h. All necessary cables, conduit and wire shall be labeled appropriately.

D. Renewable Metering

- 1. For all solar PV and Wind producing electrical systems, the metering shall follow the same specs and guidelines as described in the Electrical Metering section of ASU's EIS Guidelines.
 - a. The meter shall be installed directly after the inverter in order to capture the actual amount of power produced from the system.
- 2. For all solar thermal and water based systems, the metering shall follow the same specs and guidelines as described in the Chilled and Hot water metering section.

E. Additional Metering

- 1. Any additional metering for the EIS and/or CM applications may be required as well as requested from either CPMG and/or the FSST group.

SECTION 3: TECHNICAL GUIDELINES

2. Examples of additional metering that may be required include but are not limited to:
 - a. Gas
 - b. Domestic Water
 - c. Grey Water
 - d. Carbon
 - e. Sub-metering of various building systems
 - i. Lighting
 - ii. Plug Load
 - iii. Individual tenants
 - iv. Mechanical systems
3. Any additional metering must meet manufacture's recommendations on installation
4. Must be utility grade unless express written consent is given by ASU's Fire Systems and Support Technologies supervisor.
5. Must follow ASU's Sustainability Guidelines
6. All necessary cables, conduit and wire shall be labeled appropriately.

F. Programming

1. All programming of the main SCADA unit shall be completed by the provider of the SCADA unit and shall meet the requirements and specifications outlined by ASU's FSST Supervisor at the time of the install.
2. All IP addresses for the SCADA unit or any field device shall be provided by ASU's FSST Supervisor.
3. All programming of the data acquisition from the SCADA unit by ASU's centralized EIS servers shall be performed by ASU's FSST personnel.
4. Any additional programming of the EIS and/or CM graphical front end needs to be coordinated through ASU's partner who helps maintain these sites.
 - a. Please see the ASU FSST Supervisor for this contact information.

25 51 00 - Facility Management System

Revised March 2010

PART 1 - GENERAL REQUIREMENTS

SECTION INCLUDES

- A. Facility management system for ASU at the Tempe campus is outlined in this section. Facility management systems at other campuses shall be in accordance with requirements herein with guidance from Capital Programs Management Group.
- B. ASU at the Polytechnic campus has 3 manufacturers of control system at the present time (Johnson, Alerton and Automated Logic). It is preferred that any future systems be limited to one of these 3 manufacturers.

RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. Where work specified under other Sections of these Specifications connects to equipment or systems which are a part of this Section, provide proper connection(s) to such equipment including trade coordination. The following sections may have direct links to the installation of the FMS system:
- B. Section 00000 - General Conditions
- C. Air Terminals
 - 1. All costs associated with factory mounting of DDC controllers shall be the responsibility of the VAV Box supplier.
- D. Division 26 - Electrical Work
 - 1. 120 volt power to DDC controllers is the responsibility of the Division 26000 contractor.

DEFINITIONS

- A. Facility Management System (FMS): The entire system of hardware and software specifically designed to centrally manage building HVAC and related utilities. The FMS includes the DDC subsystem, open system ports, and open protocol bus or integrators and network routers for connection to information networks.
- B. FMS Contractor: The Facility Management System Contractor responsible for the installation of the Facility Management System specified herein.
- C. Control Wiring: Includes conduit, wire and wiring devices to install a complete Control System including motor control circuits, interlocks, thermostats, PE and EP switches and like devices. Includes all wiring from a DDC cabinet to all sensors and points defined in the Points List summary or specified herein and required to execute the sequence of operation. Includes necessary power wiring to all FMS devices, digital controllers including terminal units and actuators.

SECTION 3: TECHNICAL GUIDELINES

- D. Distributed Control: A system whereby all control processing is decentralized and independent of a central computer. The control system is built up of stand-alone controllers. A single controller failure shall not impact more than one system.
- E. Network: A system of distributed control units that are linked together on a communication highway. A network allows sharing of point information between all control units. Additionally, a network provides central monitoring and control of the entire system from any distributed control unit location. First tier networks shall provide “Peer-to-Peer” communications. Second tier networks shall provide either “Peer-to-Peer”, Master-Slave or Supervised Token Passing communications.
- F. The term “provide” means “provide complete in place”, that is, furnished and installed and ready for operation and use.

QUALITY ASSURANCE

A. General

- 1. The Facility Management System (FMS) herein specified shall be fully integrated and installed as a complete package by Johnson Controls, Inc.- Factory Branch Office. The System shall include all wiring, piping, installation supervision, calibration, adjustments, and checkout necessary for a complete and fully operational system.
- 2. The Facility Management System Contractor shall be a factory owned branch office that is regularly engaged in the engineering, programming, installation and service of Facility Management Systems of similar size and complexity.
- 3. The FMS Contractor shall have a local branch facility within a 50-mile radius of the job site. Emergency service shall be available on a 24-hour, 7-day-a-week basis.
- 4. The FMS Contractor shall be responsible for all work fitting into place in a satisfactory and neat workmanlike manner acceptable to the Owner/DP.
- 5. The FMS Contractor will coordinate with other Trade Contractors regarding the location and size of pipes, equipment, fixtures, conduit, ducts, openings, switches, outlets, and so forth, in order to eliminate any delays in the progress of the job.

B. Experience Record

- 1. The FMS Contractor shall have a minimum of ten years’ experience with the complete, turnkey installation of Facility Management Systems of similar size and technical complexity.
- 2. The FMS Contractor shall employ specialists in the field of Facility Management Systems including: Programming, Engineering, Field Supervision, and Installation. Specialists shall have a minimum of five years of experience with Facility Management Systems.

C. Products

SECTION 3: TECHNICAL GUIDELINES

1. The Facility Management System architecture shall consist of the products of a manufacturer regularly engaged in the production of Facility Management Systems, and shall be the manufacturer's latest standard of design. Controllers and DDC (Direct Digital Control) system components shall be current production products.
2. All other equipment shall be the products of the FMS manufacturers or of an approved manufacturer regularly engaged in production of specialized Facility Management System materials or equipment.
3. The Facility Management System will connect to the existing Johnson Controls, Inc. Metasys Facility Management System and Johnson Controls, Inc. Metasys operator workstation located on campus.

D. Governing Code Compliance

1. The FMS Contractor shall comply with all current governing codes ordinances and regulations, including UL, NFPA, the local Building/Fire Code, NEC, and so forth.

WORK BY OTHERS

A. Mechanical Contractor:

1. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.
2. Access doors where and as required.
3. Installation of immersion wells and pressure taps.
4. Installation of flow switches.
5. Installation of automatic control valves.
6. Installation of pressure taps, hot taps, and associated shut-off cocks.
7. All mechanical submittal data for equipment to be controlled by this section shall be provided by the Division 23 contractor for use in preparation of the Direct Digital Control System submittal.

B. Electrical Contractor:

1. Installation of 120vac power to DDC controllers shown on the electrical drawings shall be the responsibility of the Division 26 contractor.
2. Installation and power wiring of all Variable Frequency Drives (VFD's) provided under this section shall be the responsibility of the Division 26 contractor. Start-up will be provided under section 25 51 00. VFD's shall be Metasys N2 compatible.
3. All magnetic starters furnished by Electrical Contractor for mechanical equipment shall be furnished with integral 120 volt control transformers, sized to handle the additional VA needed for the controls – pilots, EP valves, etc.

Electrical Work for Controls:

- A. Complying with the principle of “unit responsibility” all electrical work for automatic controls, except as otherwise specified, or shown on the electrical drawings shall be included in Division 23.
- B. Electrical work shall, in general, comply with the following:
 - 1. All low voltage wiring in finished rooms shall be concealed below working heights and exposed above.
 - 2. Electrical work may include both line voltage and low voltage wiring as required.
 - 3. Conduit network for power systems may be used for running control high voltage wiring.
 - 4. All electrical work shall comply with the N.E.C. and local electrical codes.
 - 5. All safety devices shall be wired through both hand and auto positions of motor starting device to insure 100% safety shut-off.
 - 6. All magnetic starters furnished by Electrical Contractor for mechanical equipment shall be furnished with integral 120 volt control transformers, sized to handle the additional VA needed for the controls – pilots, EP valves, etc.
 - 7. The motor starter supplier shall provide auxiliary contacts as required for interlock by FMS contractor, the supplier shall estimate an allowance of at least one auxiliary contract per starter. All interlock and control wiring shown on the electrical prints is by the electrical subcontractor.
 - 8. Low voltage plenum rated wiring can be run exposed above an accessible ceiling. Wiring shall be neatly tied to pipes, EMT, or other devices and not laid on ceiling tile. All wiring in mechanical or electrical rooms shall be in conduit.
 - 9. All devices must be enclosed. If a cover is not part of a device, it must be mounted in a separate enclosure.
 - 10. Each DDC controller must have an independent switch to disconnect power.

WORK INCLUDED

- A. Installation of Facility Management System (FMS)
 - 1. The FMS Contractor shall furnish and install a complete Facility Management System (FMS) for all mechanical systems and other facility systems as included in the project documents. The FMS will provide the functional features as defined in Part 1-General Requirements, Part 2-Products, and Part 3-Execution of these Specifications. The FMS Contractor shall provide a complete and operational system to perform all sequences of operations as per ASU specifications.
 - 2. All device locations shall be safe from water damage. No control devices including VFD’s will be mounted under piping, valves or wall penetrations where water leakage or other damage may occur.

In addition, the following apply:

- a. The work under this Section shall include all materials and labor to perform all work required for the installation of the FMS as specified.
- b. The drawings and Specifications are complementary to one another—meaning that what is called for on one is to be considered called for in both. Where conflicts exist between the Specifications and/or drawings, the more stringent requirement shall apply.
- c. The FMS Contractor shall be responsible for field verification of site conditions and for gathering all necessary field data for all items to be provided under this contract prior to submitting his or her bid.
- d. Where work specified under other Sections of this Specification connects to equipment or systems that are listed and described in this Section, the FMS Contractor shall provide proper connection(s) to such equipment, including trade coordination.

SUBMITTALS

A. Shop Drawings, Product Data, and Samples

1. The FMS Contractor shall submit within 60 days after award installation drawings and control strategies for review.
2. Each submittal shall have a cover sheet with the following information provided: submittal ID number; date; project name, address, and title; FMS Contractor name, address and phone number; FMS Contractor project manager, quality control manager, and project engineer names and phone numbers.
3. Each submittal shall include the following information.
 - a. FMS riser diagram showing all DDC controllers, operator workstations, network repeaters, and network wiring.
 - b. One-line schematics and system flow diagrams showing the location of all control devices.
 - c. Vendor's own written description for each sequence of operations, to include the following:
 - (a) The sequences of operations provided in the submittal by the fms contractor shall represent the detailed analysis needed to create actual programming code from the design documents.
 - (b) The sequence of operations shall cover normal operation and operation under the various alarm conditions applicable to that system.
 - d. Detailed Bill of Material list for each panel, identifying: quantity, part number, description, and associated options.

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- e. Control Damper Schedules. This spreadsheet type schedule shall include a separate line for each damper and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Blade Type, Bearing Type, Seals, Duct Size, Damper Size, Mounting, and Actuator Type.
 - f. Control Valve Schedules. This spreadsheet type schedule shall include a separate line for each valve and a column for each of the valve attributes, including: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Calc CV, Design Pressure, Actual Pressure, and Actuator Type.
 - g. Cataloged cut sheets of all equipment used. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, control air system components, and so forth.
 - h. Hardware data sheets for all operator workstations, local access panels, and portable operator terminals.
- 4. FMS Contractor shall not order material or begin fabrication or field installation until receiving authorization to proceed in the form of an approved submittal. FMS Contractor shall be solely responsible for the removal and replacement of any item not approved by submittal at no cost to the Owner.
 - 5. Hardware, Shop Drawings, and Software submittals shall be provided to ASU Building Automation Systems Services for approval prior to installation.

O&M MANUALS

- A. Submit two sets of each manual: one electronic copy on CD, and one printed hard copy.
 - a. Include the following documentation in the Hardware Manual:
 - i. General description and cut sheets for all components.
 - ii. Detailed wiring and installation illustrations and complete calibration procedures for each field and panel device.
 - iii. Complete trouble-shooting procedures and guidelines.
 - iv. Complete operating instructions for all systems.
 - v. Maintenance Instructions: Document all maintenance and repair/replacement procedures.
 - b. Include the following documentation in the DDC Software Manual:
 - i. Sequence of Operations
 - ii. Software Point Name Abbreviation List. Include Name, Description, Controller Where Located, Point Type and Point ID.
 - iii. I/O Point List. Include Point Name, Controller Location, Point Number, Control Device, Range and Span.

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- c. Provide three copies of all manufacturers manuals covering the installed system.
2. Record Drawings

WARRANTY

A. Material:

1. The Control System shall be free from defects in material and workmanship under normal use and service. If within thirty six (36) months from the date of completion any of the equipment herein described is defective in operation, workmanship or materials, it will be replaced, repaired or adjusted at the option of the FMS Contractor free of charge.

B. Installation:

1. The Control System shall be free from defects in installation workmanship for a period of one year from acceptance. The FMS Contractor shall, free of charge, correct any defects in workmanship within one week of notification in writing by the Owner.

PART 2 - PRODUCTS**NETWORK CONTROLLERS****A. Network Controller**

1. The Network Controller shall be a fully user-programmable, supervisory controller. The Network Controller shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers.
2. First Tier Network – The Network Controller (NC , NIE, or NAE) shall reside on the first tier network. Each NC shall support a sub-network of a minimum of 100 controllers on the second tier network.
3. Open Systems Port – Each controller shall have the ability to connect to third-party control systems by way of an Open Systems Port, as specified or as shown on the design drawings. All programming required to implement the OSP shall reside solely within the controller and the associated device.
4. Processor – Controllers shall be microprocessor-based with a minimum word size of 16 bits and a maximum program scan rate of 1 second. They shall be multi-tasking, multi-user, and real-time digital control processors. Controller size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all second tier controllers.
6. Hardware Real Time Clock – The controller shall have an integrated, hardware-based, real-time clock.
7. Communications Ports – The NC shall provide at least two RS-232 serial data communication ports for operation of operator I/O devices, such as industry-standard printers, operator terminals, modems, and portable operator's terminals. Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or terminals.
8. Diagnostics – Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The network controller shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
9. Power Failure – In the event of the loss of normal power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Nonvolatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
 - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.

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- b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
- c. Should a controller memory be lost for any reason, the operator workstation shall automatically reload the program without any intervention by the system operators.

10. Certification – All controllers shall be listed by Underwriters Laboratories (UL).

APPLICATION SPECIFIC CONTROLLERS

A. Air Handling Unit (AHU) Controllers

- 1. Each Air Handling Unit (AHU) controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each AHU controller shall be a microprocessor-based, multi-tasking.
- 2. AHU controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the “Execution” portion of this Specification, and to address future expansion:
 - a. Air Handling Units:
 - i. Mixed Air-Single Path
 - ii. Mixed Air-Dual Path
 - iii. 100% Single Path
 - iv. 100% Dual Path
- 3. Each AHU controller shall have sufficient memory to support its own operating system and databases, including:
 - a. Control Processes
 - b. Energy Management Applications
 - c. Operator I/O (Portable Service Terminal)
- 4. Point types – Each AHU controller shall support the following types of point inputs and outputs:
 - i. Analog inputs shall monitor the following analog signals:
 - ii. 4-20 mA Sensors
 - iii. 0-10 VDC Sensors
 - iv. 1000ohm RTDs
 - b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”
 - c. Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.

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- d. Analog outputs shall provide the following control outputs:
 - i. 4.20 mA – Sink or Source
 - ii. 0-10 VDC
 - e. Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays. Inductive loads (i.e. solenoids) shall be controlled by pilot relays.
 - (a) TriState outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.
 - 5. AHU controllers shall have a library of control routines and program logic to perform the sequence of operations specified in the “Execution” portion of this Specification.
 - 6. AHU controllers shall directly support the temporary use of a portable service terminal that can be connected to the AHU via zone temperature or directly at the controller.
 - 7. Powerfail Protection – All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the AHU.
- B. Expanded Digital Controller
- 1. Each controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each controller shall be a microprocessor-based, multi-tasking, real-time digital control processor.
 - 2. Controllers shall support, but not be limited to, the following configurations of systems to address current requirements described in the “Execution” portion of this Specification, and to address future expansion.
 - a. Single boiler or chiller plants with pump logic.
 - b. Cooling towers.
 - c. Zone pressurization of labs.
 - d. Generic system interlocking through hardware.
 - 3. Point types – Each controller shall support the following types of point inputs and outputs:
 - a. Analog inputs shall monitor the following analog signals:
 - i. 4-20 mA Sensors
 - ii. 0-10 VDC Sensors
 - iii. 1000ohm RTDs

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- b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”
 - c. Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.
 - d. Analog outputs shall provide the following control outputs:
 - i. 4.20 mA – Sink or Source
 - ii. 0-10 VDC
 - e. Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays. Inductive loads (i.e. solenoids) shall be controlled by pilot relays.
 - f. TriState outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.
- 4. Controllers shall have a built-in status, and adjust panel interface to allow for the local adjustment of all setpoints, temporary override of any input or output points, and status of any points in alarm.
 - 5. Powerfail Protection – All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.
 - 6. The capability to extend the input and output capacity of the controller via Point Expansion Modules shall be provided.
 - a. The Point Expansion Modules shall communicate to the controller over a local RS-485 expansion bus.
 - b. The Point Expansion Modules shall have available a range of configurations of 4, 8, 12, or 16 data points:
 - i. Analog Inputs – 0-10V, 4-20mA, 1000 ohm RTD
 - ii. Analog Outputs – 0-10V, 4-20mA
 - iii. Digital Inputs w/ digital counter
 - iv. Digital Outputs – triacs or relay contacts
 - c. Expansion module data points shall be available for inclusion in all DX-9100 control strategies.

C. Unitary Controllers (UNT)

- 1. Each Unitary Controller shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each Unitary Controller shall be a microprocessor-based, multi-tasking.

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2. Unitary Controllers shall support, but not be limited to, the following types of systems to address specific applications described in the “Execution” portion of this Specification, and to address future expansion: Fan Coils (Two-Pipe, Four-Pipe).
 3. Point types – Each Unitary Controller shall support the following types of point inputs and outputs:
 - a. Analog inputs shall monitor the following analog signals:
 - i. 0-10 VDC Sensors
 - ii. 1000ohm RTDs
 - b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input “bouncing.”
 - c. Counter inputs shall monitor dry contact pulses with an input resolution of one HZ minimum.
 - d. Analog outputs shall provide the following control outputs:
 - i. 0-10 VDC
 - e. Binary outputs shall provide SPDT output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays. Inductive loads (i.e. solenoids) shall be controlled by pilot relays.
 - f. TriState outputs shall be paired binary outputs for use as Power Close/Power Open control output contacts rated for 2 amps at 24 VAC. Surge and noise suppression shall be provided on all pilot relays.
 4. Unitary Controllers shall have a library of control routines and program logic to perform the sequence of operations specified in the “Execution” portion of this Specification.
 5. Unitary Controllers shall directly support the temporary use of a portable service terminal that can be connected to the UNT via zone temperature or directly at the controller.
 6. Powerfail Protection – All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the UNT.
- D. VAV Terminal Unit Controller (VAV)
1. VAV controllers are to be factory mounted. Costs associated with mounting of controllers are the responsibility of the VAV box manufacturer.
 2. The VAV shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units.
 3. The VAV shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.

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4. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
5. The VAV shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
6. Each VAV shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
7. The VAV shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
8. Each VAV shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
9. The VAV shall provide the ability to download and upload VAV configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
10. VAV control setpoint changes initiated over the network shall be written to VAV non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
11. The VAV firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
12. The VAV shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
13. The VAV shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
14. The VAV shall be capable of direct electronic connection to the Alnor DB150 Balometer balancing hood. Connection shall be through a port located on the room sensor, or directly at the controller. As an alternative, software balancing tools shall be provided that will run in a hand-held Palm Pilot type PC (such as the 3COM Palm Pilot or IBM Workpad). The balancing tools shall allow adjustment of airflow setpoints and parameters, and provide permanent upload of the values entered to the VAV. The Palm Pilot shall connect to the terminal unit through the room sensor port.

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15. The VAV performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VAV shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
 - a. Absolute temperature loop error.
 - b. Signed temperature loop error.
 - c. Absolute airflow loop error.
 - d. Signed airflow loop error.
 - e. Average damper actuator duty cycle.
16. The VAV shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
 - a. Unreliable space temperature sensor.
 - b. Unreliable differential pressure sensor.
 - c. Starved box.
 - d. Insufficient cooling.
 - e. Insufficient heating.
17. The VAV shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow based on the percent of outdoor air in the primary air stream.
18. The VAV shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
19. The VAV shall be compatible with the U.S. EPA Energy Star Buildings recommendations for fan energy reduction via demand-based static pressure reset down to 2/3 of duct static pressure set point, "VSD 2/3 Reset."
20. Inputs:
 - a. Analog inputs shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
 - i. 0-10 VDC Sensors
 - ii. 1000ohm RTDs
 - iii. NTC Thermistors
 - b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."

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- c. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
- 21. Outputs
 - a. Analog outputs shall provide the following control outputs:
 - i. 0-10 VDC
 - b. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.
 - c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
- 22. VAV controllers located on boxes with reheat shall have discharge air temperature sensors.

E. Building Chilled Water Supply Isolation

- 1. A modulating valve shall be installed in the Chilled Water Supply pipe between the tunnel and the building pumps at ASU at the Tempe campus. This valve shall be controlled by an operator selectable pump suction pressure control setpoint

INPUT DEVICES

A. General Requirements

- 1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

- 1. General Requirements:
 - a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
 - b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD. Thermistors are not an acceptable alternate.
 - c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

C. Point Type	D. Accuracy
E. Chilled Water	F. + .5°F.
G. Room Temp	H. + .5°F.
I. Duct Temperature	J. + .5°F.
K. All Others	L. + .75°F.

- 1. Room Temperature Sensors

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- a. Room sensors shall be constructed for either surface or wallbox mounting.
 - b. Room sensors shall have the following options when specified:
 - (a) Setpoint reset slide switch providing a +3 degree (adjustable) range.
 - (b) Individual heating/cooling setpoint slide switches.
 - (c) A momentary override request push button for activation of after-hours operation.
 - (d) Analog thermometer.
2. Thermowells
- a. When thermowells are required, the sensor and well shall be supplied as a complete assembly, including well head and Greenfield fitting.
 - b. Thermowells shall be pressure rated and constructed in accordance with the system working pressure.
 - c. Thermowells and sensors shall be mounted in a threadolet or 1/2" NFT saddle and allow easy access to the sensor for repair or replacement.
3. Outside Air Sensors
- a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
 - b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
 - c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.
4. Duct Mount Sensors
- a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
 - b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
 - c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
5. Averaging Sensors
- a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.

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- b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
- c. Capillary supports at the sides of the duct shall be provided to support the sensing string.

M. Humidity Sensors

- 1. The sensor shall be a solid state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
- 2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
- 3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. [more information]
- 4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
- 5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
- 6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.

N. Pressure Transmitters

- 1. General Air and Water Pressure Transmitter Requirements:
 - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
 - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
 - c. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
 - d. Pressure sensors in hydronic systems must be rated for # 3000 psi or greater and 1000 psi differential pressure or greater.

O. Flow Monitoring

- 1. Air Flow Monitoring
 - a. Duct Air Flow Measuring Stations

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- i. Each device shall be designed and built to comply with, and provide results in accordance with, accepted practice as defined for system testing in the ASHRAE Handbook of fundamentals, as well as in the Industrial Ventilation Handbook.
- ii. Airflow measuring stations shall be fabricated of 14-gauge galvanized steel welded casing with 90 Deg. connecting flanges in configuration and size equal to that of the duct into which it is mounted. Each station shall be complete with an air directionalizer and parallel cell profile suppressor (3/4" maximum cell) across the entering air stream and mechanically fastened to the casing in such a way to withstand velocities up to 6000 feet per minute. This air directionalizer and parallel cell honeycomb suppressor shall provide 98% free area, equalize the velocity profile, and eliminate turbulent and rotational flow from the air stream prior to the measuring point.
- iii. The total pressure measurement side (high side) will be designed and spaced to the Industrial Ventilation Manual 16th Edition, Page 9-5. The self-averaging manifolding will be manufactured of brass and copper components.
- iv. The static pressure sensing probes (low side) shall be bullet-nosed shaped, per detailed radius, as illustrated in Industrial Ventilation Manual 16th Edition, Page 9-5.
- v. The main take-off point from both the total pressure and the static pressure manifolds must be symmetrical.
- vi. Total and static pressure manifolds shall terminate with external ports for connection to control tubing. An identification label shall be placed on each unit casing, listing model number, size, area, and specified airflow capacity.
- vii. Installation Considerations
 - (a) The maximum allowable pressure loss through the Flow and Static Pressure elements shall not exceed .065" w.c. at 1000 feet per minute, or .23" w.c. at 2000 feet per minute. Each unit shall measure the airflow rate within an accuracy of plus 2% as determined by U.S. – GSA certification tests, and shall contain a minimum of one total pressure sensor per 36 square inches of unit measuring area.
 - (b) The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.

SECTION 3: TECHNICAL GUIDELINES

- (c) Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
 - (d) Where control dampers are shown as part of the airflow measuring station, opposed blade precision controlled volume dampers integral to the station and complete with actuator, pilot positioner, and linkage shall be provided.
 - (e) Stations shall be installed in strict accordance with the manufacturer's published requirements, and in accordance with ASME Guidelines affecting non-standard approach conditions.
 - b. Static Pressure Traverse Probe
 - i. Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
- 2. Water Flow Monitoring
 - a. Flow sensor range shall be from zero (0) flow to one hundred and fifty (150) percent of the maximum rated flow for each application and be of industrial grade. Minimum accuracy at full scale shall be +/- 1 percent of full scale.
 - b. All water flow sensors shall be installed in a manner which permits retraction and replacement of the sensor for service without interrupting or affecting the application being monitored (hot taps).
 - c. Liquid flow sensors that are not used for BTU monitoring, shall be Onicon insertion-type turbine flow sensors (or ASU/BAS approved equal) installed as hot tap. Install in strict conformance with manufacturer's recommendations.
- P. Campus Energy Information System- EIS
 - 1. General requirements
 - a. The BAS contractor shall be responsible for the complete installation of all system components, connections and configuration.
 - b. Electrical usage shall be monitored using a VERIS H8036 KW meter.
 - c. Chilled water shall be monitored using a Controlatron BTU meter. New installations shall require thermo wells for temperature sensors. Existing installations may use strap-on sensors.

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- d. Steam usage – Total steam usage must be metered. If applicable a Controlatron BTU meter can be used for Heating Hot water. If heating hot water is not representative of the total steam load, then Rosemount steam flow, temperature, and pressure instruments shall be installed.
- e. EIS field controllers shall be an Emerson ROC 809. Communication to metering devices shall be by Modbus protocol when applicable. Analog outputs shall be provided to output systems flow, temperature and pressure values to the JCI Metasys BAS.
- f. EIS field controllers shall be connected to the campus EIS fiber network.
- g. The BAS contractor shall be responsible for the complete Fiber installation to the nearest campus building Switch or Hub.
- h. Configuration shall include mapping points to the EIS workstation.
- i. Condensate Return temperature must be monitored by the EIS.

Q. Status and Safety Switches

1. General Requirements

- a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the FMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.

2. Current Sensing Switches

- a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
- b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
- c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.

3. Air Flow Switches

- a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

4. Air Pressure Safety Switches

- a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.

SECTION 3: TECHNICAL GUIDELINES

- b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
- 5. Water Flow Switches
 - a. Water flow switches shall be equal to the Johnson Controls P74.
- 6. Low Temperature Limit Switches
 - a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
 - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
 - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

OUTPUT DEVICES

A. Actuators

- 1. General Requirements
 - a. Damper and valve actuators shall be electronic.
- 2. Electronic Damper Actuators
 - a. Electronic damper actuators shall be direct shaft mount.
 - b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in either direction, and a gear release to allow manual positioning.
 - c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

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- d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as “quick acting,” shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
- 3. Electronic Valve Actuators
 - a. Electronic valve actuators shall be manufactured by Belimo.
 - b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
 - c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized based on valve manufacturer’s recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
 - d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
 - e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.

B. Control Dampers

- 1. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.
- 2. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

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3. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 48". Damper blades shall be 16-gauge minimum and shall not exceed six (6) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. Additional stiffening or bracing shall be provided for any section exceeding 48" in height. All damper bearings shall be made of stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.5 cfm per square foot when closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.
4. Air foil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Johnson Controls D-1300, Ruskin CD50, and Vent Products 5650.
5. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below.
6. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jack shaft shall receive at least one actuator to reduce jack shaft twist.

C. Control Relays

1. Control Pilot Relays
 - a. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
 - b. Contacts shall be rated for 10 amps at 120VAC.
 - c. Relays shall have an integral indicator light.

D. Control Valves

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved.

SECTION 3: TECHNICAL GUIDELINES

2. Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves pressure drop at design flow through control valves shall be no more than 3 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 3 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 3 PSI drop.
3. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all hot and chilled water applications, except those described hereinafter. The valve discs shall be composition type. Valve stems shall be stainless steel.
4. Delta or Belimo Ball valves, with stainless steel ball and stem, shall be acceptable for water terminal reheat coils, radiant panels, unit heaters, air handler units, package air conditioning units, and fan coil units.
5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

Graphics:

- A. The graphics shall be able to display and provide animation based on real time data that is acquired, calculated, or entered.
- B. Multiple graphic applications shall be able to execute at any one time on a single workstation.
- C. The operator shall be able to configure the speed at which data will be updated on the specific graphic.
- D. Basic graphical objects – All graphics shall be able to be constructed from the following basic graphical objects:
 1. Single or multi-segment lines of any thickness – line styles at a minimum shall include: solid, dotted, and dashed.
 2. Rectangles, Polygons, Arcs, Circles, and Ellipses – User may fill with any color or no fill, and may configure the thickness of the outline.
 3. Text Boxes – User may configure text boxes with any W98 True Type font, any foreground color, any background color, and with 8 or more thickness levels.
- E. Animation: Any basic object, any group of basic objects, or any symbol or group of symbols, shall be capable of being animated in the following manner:

SECTION 3: TECHNICAL GUIDELINES

1. Color Change – up to 32 different color states.
 2. Size – Any object's size shall be able to be animated based on the value of an analog variable.
 3. Movement – Any object can be animated to move either in a straight line, or can follow a configured path of any number of line segments.
 4. Rotation – Any object shall be able to be animated up 360 degrees.
 5. Visibility – It shall be possible to make any object dynamically appear or disappear based on the true/ false result of any Boolean equations.
- F. Operation from Graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by any of the following methods of operator interaction:
1. By selecting the object with either the left, middle, or right mouse button:
 - a. Load a specific graphic.
 - b. Drag / Drop to load a graphic in a selected window.
 - c. Link forward or backward to another graphic.
 - d. Change or toggle the value of an object.
 - e. Launch an executable application.
 2. Slider action – Any object can be defined to be a slider and configured to change a setpoint or other variables as the user slides an object over a configured geometry.
 3. Dial Action – Any object can be configured so that it can change a configured analog value over a range as the object is rotated. This is most often used to represent dials.
 4. Data Entry – A variable is displayed on a graphic. By selecting the variable, the data entry function for the value is enabled and the operator is able to enter a new value for the variable.
- G. Graphic Editing Tool: A graphic editing tool shall be provided that allows for the creating and editing of graphic files. The graphic editor shall be capable of performing all drawing functions, defining all calculations to be executed as part of the graphic, defining all animations, and defining all runtime binding. It is not acceptable for separate programs to be required to do these various functions.
1. The graphic editing tool shall in general provide for the creation and positioning of objects by dragging from tool bars and positioning where required. It shall provide the ability to create, at a minimum, all of the object types, all of the animation algorithms, and all of the action types referenced in this section.
 2. In addition, the graphic editing tool shall be able to add additional content to any graphic by importing any Windows metafile (.wmf) or any bitmap file (.bmp).

- H. Symbol library – The FMS system shall be provided with a very complete symbol library containing all of the basic symbols used to represent HVAC, Fire, and Security components of a typical FMS system:
 - 1. Symbols shall be able to be added to any graphic display being constructed by simply dragging the symbol from the library to the graphic under construction.
 - 2. Creating Symbols- The user shall be able to add any number of new symbols to the symbol library. Symbol generation shall include all of the abilities described for the graphic editor.
 - 3. Any drawing – including all objects contained therein, and all animation definitions, and all action definitions – shall be able to be grouped and saved into the symbol library for re-use in graphic displays. Symbols shall be able to include implicit bindings or aliased bindings, as described in the following sections.
- I. Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags. The same graphic display can then be used an unlimited number of times by simply providing a look-up table for the aliases that correspond to each individual use of the graphic.
- J. Graphical displays shall include room, zone, and sensor/thermostat locations.

PART 3 - PERFORMANCE/ EXECUTION

INSTALLATION PRACTICES

- A. HVAC Control System Wiring
 - 1. All low voltage (under 120 volt) conduit, wiring, accessories and wiring connections required for the installation of the Facility Management System, as herein specified, shall be provided by the FMS Contractor unless specifically shown on the Electrical Drawings under Division 26 Electrical. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.
 - 2. All system input wiring shall be twisted shielded pair, minimum 18 gauge wire. All system analog output wiring shall be twisted shielded pair/3-wire as required, minimum 18 gauge wire. Preconfigured cables between Terminal Unit Controllers and Thermostats are acceptable, minimum 24 gauge.
 - 3. All Class 2 (24VAC or less) wiring in concealed areas or in mechanical rooms shall be installed in conduit.
 - 4. Exposed wiring shall only be allowed in concealed accessible locations.
 - a. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.

SECTION 3: TECHNICAL GUIDELINES

5. All wiring in mechanical rooms shall be in conduit.
- B. DDC System Multi-conductor Instrumentation and Communication Cabling Standards:
 1. Analog input, Analog Output, Binary Input, Binary Output, 24 VAC and General Purpose Cabling
 - a. Cable shall consist of copper conductors not less than No. 18 AWG-stranded.
 - b. Shall be 2 or 3 conductor twisted cable with a drain wire.
 - c. Cable shall have a 100% overall shield.
 - d. Cable shall be plenum-rated.
 - e. Cable shall meet or exceed NEC voltage rating of 300V.
 - f. Cable shall be NEC type CMP.
 - g. Cable shall meet or exceed UL temperature rating of +60 degrees C.
 - h. Cable shall be labeled at a minimum of every 18" with the DDC system manufacturer's name and the type of signal carried within the cable, i.e. Analog Input, Analog Output, Binary Input, Binary Output, 24 VAC.
 - i. Each of the cable types specified in the Item A shall be of a different color coding for easy identification and troubleshooting. Recommended color coding:
 - i. Analog Input Cable Yellow
 - ii. Analog Output Cable Tan
 - iii. Binary Input Cable Orange
 - iv. Binary Output Cable Violet
 - v. 24 VAC cable Gray
 - vi. General Purpose Cable Natural
 2. Primary and Secondary Communications Network Cabling
 - a. Cable shall be of type recommended by the DDC system manufacturer.
 - b. Cable shall be shielded.
 - c. Cable shall be plenum-rated.
 - d. Cable shall meet or exceed NEC voltage rating of 150V.
 - e. Cable shall meet or exceed UL temperature rating of +60 degrees C.
 - f. Cable shall be labeled at a minimum of every 18" with the DDC System manufacturer's name, system name and the communications network name.

SECTION 3: TECHNICAL GUIDELINES

- g. Each of the cable types shall be of a different color-coding for easy identification and troubleshooting and shall be of a different color than the cable specified in Item A above.
 - 3. Room Sensor Cabling
 - a. Cable shall consist of copper conductors not less No. 24 AWG.
 - b. Shall be multi-paired (at least two pairs) twisted cable.
 - c. Cable shall have a 100% overall shield.
 - d. Cable shall be plenum-rated.
 - e. Cable shall meet or exceed NEC voltage rating of 300V.
 - f. Cable shall be NEC type Article 800-CMP.
 - g. Cable shall meet or exceed UL temperature rating of +75 degrees C.
 - h. Cable shall be labeled at a minimum of every 18" with the DDC system manufacturer's name and labeled as a stat cable.
- C. Wire Labels/ Device Tagging:
 - 1. Controller Identification. All controllers shall be identified by a nameplate securely fastened to the outside of the controller enclosure.
 - 2. Panel Identification. All local control panels shall be identified by a nameplate securely fastened to the outside of the controller enclosure.
 - 3. Field Devices. All field devices shall be identified by a typed (not handwritten) securely attached tag label. Each tag will consist of a stainless steel wire and stainless steel tag. The device name will match the object name on the control drawings. One tag will be provided for every valve, sensor, etc.
 - 4. Panel Devices. All panel devices shall be identified by a typed label. Each tag shall consist of a black plastic tag with white lettering. Device names will match object on control drawings. One tag will be provided for every panel mounted device (transformers, controllers, etc.) Tags will be securely fixed to panel device with sticky back tape.
 - 5. Wire Identification. All low and line voltage control wiring shall be identified as referenced to the associated control diagram, at each end of the conductor or cable. Identification shall be permanently secured to the conductor or cable and shall be typed.
- D. Digital Controller Systems
 - 1. Each system will be provided with its own dedicated direct digital controller or application specific controller. Mechanical systems such as AHUs, VAVs or Packaged system shall not be controlled from more than 1 application specific controller.

2. Systems that use second tier controllers as point expansion for system controllers shall only be allowed under when the I/O points are directly controlled by the CPU of the local application specific controller.

TRAINING

- A. The contractor shall provide the following training.
 1. The control contractor shall provide 4 hours of on-site orientation by a field engineer whom are fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the control system software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

COMMISSIONING

- A. Commissioning the Facility Management System is a mandatory documented performance requirement of the selected FMS Contractor for all control systems detailed in this Specification and sequence of operations. Commissioning shall include verification of proper installation practices by the FMS Contractor and subcontractors under the FMS Contractor, point verification and calibration, system/sequence of operation verification with respect to specified operation, and network/workstation verification. Documentation shall be presented upon completion of each commissioning step and final completion to ensure proper operation of the Facility Management System.
 1. Commissioning documents will be provided to ASU Building Automation Systems Services upon completion.
- B. Testing Procedure
 1. Upon completion of the installation, the FMS Contractor shall start-up the system and perform all necessary testing and run diagnostic tests to ensure proper operation. The FMS Contractor shall be responsible for generating all software and entering all database information necessary to perform the sequences of control herein specified.
- C. Field Points Testing
 1. This step shall verify that all of the installed points receive or transmit the correct information prior to loading/activating the system software.
 2. ON/OFF commands from the workstation shall be performed in order to verify each binary output point.
 3. All binary input points are to be tested using the HAND/OFF/AUTOMATIC selector switch on the associated motor control center or by manually jumpering across the field device contacts.
 4. All analog output points shall be tested using a command from the workstation to modulate the output device from minimum calibrated signal to maximum calibrated output.

SECTION 3: TECHNICAL GUIDELINES

5. All analog input points are to be tested by comparing the reading obtained through the workstations or portable terminal to the value of an independent testing meter.

D. Noncompliant Items:

1. The Contractor shall remove and replace, at its expense, all items that are not in compliance with the Specification requirements.

SEQUENCES

- A. Sequences of operations shall be project specific, comply with ASU standards, and must be approved by ASU Building Automation System Services.

SCOPE OF WORK

T = Temperature Control Contractor

M= Mechanical Contractor

E = Electrical Contractor

O = Other

<u>System Description</u>	<u>Supplied By</u>	<u>Mounted By</u>	<u>Wired/Piped By</u>
STEAM/HOT WATER			
Manufacture supplied controls	O	T	T
Manufacture interlocks	-	-	M
Thermowell	T	M	-
Steam/HW control valve(s)	T	M	T
Temperature sensor	T	T	T
Pressure transmitter	T	M	T
GPM Flow meter/transmitter	T	M	T
Pump differential pressure switch	T	M	T
Pump control relay/current sensor	T	T	T
Variable Frequency Drive (Power)	O	O	E
Variable Frequency Drive (Control)	-	-	T

SECTION 3: TECHNICAL GUIDELINES

Combustion Air Damper	T	M	T
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CHILLED WATER

Manufacture supplied controls	O	T	T
Manufacture interlocks	-	-	M
Thermowell	T	M	-
CHW control valve(s)	T	M	T
Temperature sensor	T	T	T
Pressure transmitter	T	M	T
GPM Flow meter/transmitter	T	M	T
Pump differential pressure switch	T	M	T
Pump control relay/current sensor	T	T	T
Variable Frequency Drive (Power)	O	O	E
Variable Frequency Drive (Control)	-	-	T
Refrigerant monitoring system	T	T	T
Pump Suction Pressure Sensor	T	M	T

AIR HANDLING UNIT

Manufacture supplied controls	O	T	T
Manufacture interlocks	-	-	M
Control damper(s)	O	M	M
Control damper actuator(s)	T	T	T
Steam/HW/CHW control valve(s)	T	M	T
Temperature/humidity sensor(s)	T	T	T
Pressure transmitter	T	T	T
CFM Flow meter/transmitter	T	M	T

SECTION 3: TECHNICAL GUIDELINES

Differential pressure switch	T	T	T
Control relay/current sensor	T	T	T
Variable Frequency Drive (Power)	O	O	E
Variable Frequency Drive (Control)	-	-	T

AHU SAFETIES

Temperature low limit	T	T	T
Humidity high limit	T	T	T
Static pressure switch	T	T	T
Duct smoke detector fan interlock	O	O	E
Duct smoke detector to fire alarm system	E	E	E

VAV BOX

VAV box controls	T	O	O
Space temperature sensor	T	T	T
Hot water reheat control valve	T	M	T

UNIT VENTILATOR

Unit ventilator controls	T	O	O
Control damper(s)	O	M	T
Control damper actuator(s)	T	T	T
Steam/HW/CHW control valve(s)	T	M	T
Temperature/humidity sensor(s)	T	T	T
Differential pressure switch	T	T	T
Control relay/current sensor	T	T	T

SECTION 3: TECHNICAL GUIDELINES

FAN COIL UNIT

Control damper(s)	O	M	T
Control damper actuator(s)	T	T	T
Steam/HW/CHW control valve(s)	T	M	T
Temperature/humidity sensor(s)	T	T	T
Differential pressure switch	T	T	T
Control relay/current sensor	T	T	T

CABINET/UNIT HEATER

Line voltage thermostat	T	T	T
Line voltage control valve	T	M	T
Line voltage aquastat	T	T	T

FTR/RADIANT PANELS

Temperature sensor	T	T	T
Control valve	T	M	T

EXHAUST FAN

Control relay/current sensor	T	T	T
Control damper(s)	O	M	T
Control damper actuator(s)	T	T	T

NETWORK

BAS communication wiring	T	T	T
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120V ELECTRICAL POWER

SECTION 3: TECHNICAL GUIDELINES

120V to DDC panels	E	E	E
120V to VAV box	E	E	E
120V to Operator work station	E	E	E
120V circuit breaker to DDC Panel	E	E	E

CONTROL WIRING

DDC panel input/output wiring	T	T	T
DDC panel to motor starter	T	T	T
24V power to dampers/valves	T	T	T

DIVISION 26 - ELECTRICAL

26 01 00 - General Information Of Electrical Systems

Revised May 2013

These guidelines and standards shall be enforced for new construction, remodels, tenant improvements, retrofits, additions, removals, demolition or any other project requiring electrical change on ASU property. The primary objective of these guidelines is to achieve consistency and accuracy in electrical facilities engineering design through awareness and standardization.

Code and Ordinances:

- A. All materials and workmanship shall comply with all applicable Codes, Specifications, Local, State Ordinances, Industry Standards and provision found in this document.

Applicable Codes and Standards shall include all State Laws, Local Ordinances and the applicable requirements of the following accepted Codes and Standards. Conform to, although not limited to, the following:

1. International Building Code (IBC)
 2. National Electric Code (NEC)
 3. International Fire Code (IFC)
 4. National Fire Protection Association (NFPA)
 5. International Energy Conservation Code (IECC)
 6. National Electrical Testing Association (NETA)
- B. Where conflicts occur within different codes the more stringent applicable portion of the conflicting codes shall be used unless written permission is granted by Capital Programs Management Group electrical engineer.

Electrical System Overview – ASU Tempe Campus:

- A. The Utility Company specifies the location of the service point. At the ASU Tempe Campus, this service point is in four locations:
1. The Central Plant.
 2. The west substation, located by Parking Structure #3.
 3. The northeast corner of University Drive and Veterans Way, parking lot #57.
 4. The CHP, southwest of Parking Structure #4.
- B. The load side of the main APS meter sections is the premises wiring and is the property of ASU. This is classified by ASU as the total load. At the ASU Tempe campus, the service points and the disconnecting means are located in the same section shared by APS by a common buss. The service point is the point on the wiring system where the serving utility ends and where the premises' wiring begins.

- C. At the ASU Tempe campus, individual building services shall be classified as part of ASU's primary distribution system and not as the utility service point. The primary electrical distribution system throughout the ASU Tempe campus is an underground system distributed through a network of utility tunnels and/or underground duct bank systems. The electrical distribution system on campus is a nominal 12.5 KV, 3-wire, DELTA connected primary with a 4 wire WYE secondary. The primary distribution conductors feed into distribution transformers, designed to step-down the primary voltage into a secondary voltages bases on load requirements.
- D. For new design, voltage for incandescent lighting, receptacles, etc., shall be designed at 120/208 volt, 3-phase, 4-wire, serviced from secondary dry type transformers with 480-volt, 3-phase, 3-wire, DELTA primary with a ground sized to the secondary conductors. Transformers may also be 120/208V - 3 phase - 4 wire "WYE" for the entire building requirements. This decision shall be made by the Design Engineer and approved by ASU CPMG A/E Electrical Engineer, and Electrical Services and will be influenced by the relationship between the motor lighting load and the total load within the building.
- E. All buildings shall be designed and built with a ground system that references a single point of ground with provisions for expansion. Each new building shall provide the necessary switches and transformers for its connected load. A load analysis shall be performed to determine the adequacy of the primary feeders for interconnection, or upgrade of the primary system. ASU's primary distribution system conductors shall be sized based on the requirements of Section 26 05 13.

Emergency Power Overview – ASU Tempe Campus:

- A. Emergency power for life safety emergency loads is supplied from the following locations:
 - 1. The Central Plant.
 - 2. The CHP, southwest of Parking Structure #4.
 - 3. Independent emergency generators throughout the site.
- B. Emergency power from the Central Plant is distributed via the utility tunnel system. Emergency power from the Central Plant is distributed at 4,160 volts to selected 4,160/600V or 4,160/480V transformers located throughout the campus, to distribution panels for interconnection. New buildings will require a step-down transformer for emergency power; or if feasible, a breaker from one of the distribution panels is all that would be necessary.
- C. Emergency power from the C.H.P. is distributed via an underground conduit system. Emergency power from the C.H.P. is distributed at 4,160 volts to selected 4,160-277/480V transformers to distribution panels located in the ISTB1, HAV and Bio Design buildings, for interconnection. New loads connecting to this system shall be approved through CPMG prior to any design work.
- D. Standby or legally required systems shall not be connected to any emergency power systems. These loads shall be powered from a separate system within the project and its budget.

SECTION 3: TECHNICAL GUIDELINES

- E. ASU at the Tempe campus has in place a 600 / 480 volt emergency power system throughout the tunnel system which is in the process of being upgraded to a 4160 volt distribution system and has selectively located 600 volt distribution panels.
- F. New buildings must be designed to feed emergency power from the 4160 volt emergency power generator system installed in Central Plant with the use of 4160-277/480 volt step down transformer. Each building will have its own automatic emergency transfer switch (AETS). Normal power supply will be from the Service Entrance Section at the individual building and will be the primary, or normal, source of power to the AETS.
- G. Additional information on Electrical Reliability and Redundancy may be found in Appendix 2: Electrical Reliability Standards, found in Section 1 of the ASU Design Guidelines.

26 02 00 - General Design Requirements / Recommendations Of Electrical Systems

Revised May 2013

Equipment and Material:

- A. Equipment, and materials, shall be new, unused, without blemish or defect and manufactured not more than twelve (12) months prior to installation.
- B. Equipment, fixtures and materials shall be U.L. listed and labeled, or certified by a nationally recognized independent testing laboratory acceptable to the ASU Capital Programs Management Group Electrical Engineer.
- C. Materials, fixtures and equipment shall not be specified if they are known to be obsolete, end of life, discontinued or have a spare part supply life less than five (5) years beyond completion of the facility.
- D. All drawing symbols must be shown on the drawings in a section describing the symbols and giving specifications of the item.
- E. For the purpose of Division 26, Electrical, the term "approved equal" will be the determination of the ASU Electrical Services Supervisor and the Capital Programs Management Group Director, who will have the final decision.
- F. ASC Ratings depending upon feeders (as approved by Campus Engineer) to meet calculation (for full calculated loads).

General Requirements:

- A. A maximum of 4 receptacles will be allowed on each 20 amp circuit, with a dedicated circuit for all appliances such as; copiers, laser printers, microwave and refrigerator circuits.
- B. A maximum of 3 circuits is allowed in each conduit for all new installations.
- C. Main feeders, or branch circuit conductors shall not be brought into the back of a power panel or switchboard, unless previously approved by the Campus Engineer.
- D. No underground excavating, digging, drilling, coring, sinking rods, driving spikes, or any work that would move grade level earth will be started until a formal Blue Stake service has been requested and completed.
- E. Power supply and identification shall be provided for electric door locks. Control location for monitoring shall be as approved by ASU Lock Shop.
- F. Provide conduit sleeves in all floor-to-structure walls for the installation of all conduits that pass through wall. Sleeves shall be 4" for installation of data cabling. Install fire stop at all rated walls matching the walls rating.
- G. All drawing symbols must be shown on the drawings in a section describing the symbols and giving specifications of the item.

SECTION 3: TECHNICAL GUIDELINES

- H. For the purpose of Division 26, Electrical, the term "approved equal" will be the determination of the ASU Facilities Management Electrical Services Supervisor and the Facilities Planning/Management Director, who will have the final decision.

Installations in Mechanical Rooms and Equipment Locations

- A. Provide adequate safe access and manufacturer's recommended working clearances for all equipment.
- B. Provide for replacement of the largest pieces of equipment without removing permanent walls, large items of equipment or equipment essential to the principal on-going day to day building use.
- C. Provide direct access from the exterior for major electrical rooms exceeding 100 net square feet.
- D. In phased projects, electrical rooms shall be sized to include equipment for all the phases.
- E. Electrical rooms shall have a floor drain.

26 03 00 - Electrical Demolition

Revised March 2010

- A. Power shutdowns required to perform demolition shall be coordinated with ASU CPMG and Electrical Services Supervisor.
- B. All conduit and conductors that are removed under demolition work shall not be reused.
- C. At the completion of a project, turn over to ASU all removed electrical devices.
- D. Where existing devices are to be removed, the conduit and conductors connecting to them shall be removed all the way back to the nearest remaining device, or back to panelboard.
- E. Relocated devices shall have their associated conduits and conductors extended to new location. Install new junction boxes conduit and conductors in order to restore system to operating condition.
- F. Where an existing device is to be removed, and it, or its associated box, is connected in series with any remaining downstream devices, install new conduits, conductors, and boxes, as required jumping the removed device. The operation of the remaining devices shall be retained.

26 05 00 - Common Work Results For Electrical

Revised May 2013

Wiring connections to equipment included in other sections.

Package Equipment

- A. The contractor or vendor furnishing a piece of packaged equipment with electrical component(s) shall furnish and install the equipment. The electrical contractor will provide the wiring and make the connections to the components.
- B. Line control devices will be delivered to the electrical contractor by the contractor furnishing the equipment, and the electrical contractor will mount and connect these items.
- C. Motor disconnect switches circuit breakers, variable frequency drive, for package equipment will be furnished, installed, and connected by the electrical contractor where required.
- D. The control items, wiring diagrams, and the responsibility for correct installation and function of the control system shall be covered under that section of the project specifications where the equipment is specified to be furnished.
- E. The electrical contractor will run electrical conductors to a designated location near the controller and terminate in a disconnect switch or breaker of a specified size and type.

Elevators

- A. Electrical wiring of elevators and/or cranes will be done by an Arizona State licensed elevator contractor.
- B. The electrical contractor shall provide a convenience outlet and light in the elevator pit, elevator machine room, and car top; and where emergency power is available, shall be connected to the emergency power panel. Elevator raceways will be installed per this division.
- C. The safety switch for the elevator equipment shall contain normally closed and normally open dry auxiliary contacts that operates with the blades of the safety switch.
- D. Provide an elevator shunt-trip device that upon activation of a heat detector in the elevator machine room or within the elevator shaft will disconnect power to the elevator machine room. All elevator smoke or heat detection devices must report to the building fire alarm panel.

Special Systems

Conduit and wiring shall be installed as required by this division for fire alarm systems, program clock system, emergency power, and central controls system. Telephone, TV antenna and data systems shall be installed per ASU Telecommunications Guidelines.

26 05 13 - Medium Voltage Cables:

Revised May 2013

Description: Medium voltage cable and accessories for systems rated above 600 volts to 15,000 volts.

Cable

- A. Medium Voltage Cables shall be new, 5kv & 15kv single copper compact stranded conductor EPR (Ethylene Propylene Rubber) shielded power cable rated at 5000 & 15000 volts, 133% level type MV-105. three-phase conductors as per electric services direction, with a minimum #4/0 bare ground. Phase conductors shall be suitable for use in wet and dry locations in conduit, underground ducts, direct burial, cable tray and aerial installations. ASU standard specifications for medium voltage cable are below.

MEDIUM VOLTAGE CABLE SPECIFICATIONS

Scope

This specification covers single conductor shielded power cable insulated with an ozone and discharge resistant, flexible, rubber-like thermosetting dielectric.

The cable shall be suitable for use in wet and dry locations in conduit, underground duct systems, cable tray and aerial installations. The cable shall be rated 105 degree C for normal operation, 140 degree C for emergency overload operation and 250 degree C for short circuit conditions. Emergency overload operation may occur for periods up to 1500 hours cumulative during the life of the cable.

Standards:

All cable shall conform to the current standards:

- a. Insulated Cable Engineers Associated (ICEA) S-94-649
- b. American Society for Testing and Materials (ASTM)
- c. Association of Edison Illuminating Companies (AEIC) CS-6, latest edition
- d. UL MV-105.

Basic Construction:

1/C compact stranded copper, triple tandem extruded semi-conducting ethylene-propylene rubber strand shield, .220" EPR insulation for 15kv and .115" EPR for 5kv, extruded semi-conducting ethylene-propylene rubber insulation shield, shielding tape, #20 drain wires, separator tape and overall jacket.

Conductor:

Conductor shall be uncoated copper compact stranded per ASTM B-496.

Conductor Shield:

Conductor shield shall be extruded layer of semi-conducting EPR thermosetting compound with a volume resistivity not in excess of 100 ohm meter at 90 degree C shall be applied over the conductor. The compound shall have a minimum elongation after an air oven test at 121 degree C for 168 hours of 100% and the brittleness temperature not warmer than -40 degree C.

Insulation:

The Insulation shall be EPR; a red colored flexible thermosetting dielectric based on an ethylene propylene elastomer. The ethylene content of the elastomer used in the insulation compound shall not exceed 72% by weight of ethylene nor shall the insulation compound contain any polyethylene, both features to limit the degree of susceptibility to treeing experienced by highly crystalline materials. The cable manufacturer shall compound the insulation in its own facility using a closed system to insure maximum cleanliness. The EPR insulation shall be triple tandem extruded with the EPR based conductor and insulation shields to prevent inter-surface contamination. The extrusion operation shall be performed by three separate in-line extruder heads thereby permitting the measurement and accurate individual control of the wall thickness of each layer of compound as the cable is being manufactured.

Insulation Shield:

The insulation shield shall be an extruded semi-conducting EPR compound with a volume resistivity not in excess of 10 ohm meters at 90 degree C when tested per ICEA S-94-649. It shall be clean stripping from the insulation when preparing terminations and splices.

Metallic Shield

Provide one of the following:

- A. A single 5 mil copper tape shall be helically wrapped with a 12-1/2% nominal overlap along with the appropriate number of #20 AWG drain wires placed on the outside of the copper tape to double the phase to ground fault capacity of the 5 mil copper tape.
- B. Two, 5 mil copper tapes (2 x 5 mil) helically wrapped with an opposite lay and 12.5% nominal overlap.

Jacket:

The overall jacket shall be thermoplastic black PVC for conduit or direct burial.

Corona:

Each reel of completed power cable shall comply with the maximum partial discharge test and shall be performed in accordance with the procedures of Section F of AEIC CS-6. Manufacture is required to submit the X-Y recording graph showing flat line corona test results.

Quality Assurance:

The medium voltage cable shall be manufactured and tested under the control of a Quality Assurance program which meets the requirements of Section 10 degree CRF50, Appendix B of the Federal Register as defined in ANSI N45-2.

SECTION 3: TECHNICAL GUIDELINES

Each reel of completed power cable shall be newly manufactured (no more than 12 months old) and shall bear a tag containing name of manufacturer, NEC designation, year of manufacture and all information noted in this section.

Cable manufacturer shall be Okonite Okoguard®-Okoseal® MV-105, or approved equal.

Splices and terminations

- A. All splices and terminations shall be performed by qualified cable splicer's who have had at least eight (8) years experience in the "Cable Splicer" classification and at least five (5) years experience with this type of cable. The qualifications of the cable splicer's shall be submitted for approval to the ASU Electrical Services department.
- B. Provide molded rubber straight type separable connector-cable joints, cable bushing adapters for in-line cable connections to sectionalizing switches and stress cones for applications on EPR, insulated power cables. The connectors shall be fully dead front.
- C. Splice and termination kits shall be approved by ASU Electrical Services Supervisor. University personnel shall be notified 72 hours in advance so that they may observe each splice or termination being made.

Warranty

- A. Manufacturer shall offer a 40 year warranty against dielectric breakdown due to materials or workmanship. The warrantee period shall be from the date of shipment if installed, terminated, and operated within acceptable industry practices and standards. In the unlikely event the cable is found to be defective in either material or workmanship, as mutually agreed upon by the purchaser and the manufacture, the manufacture shall agree to repair or to replace the defective length(s) of cable during the 40-year warranty. This warranty shall be based upon the cable being installed and field tested in accordance with the manufactures procedures.

26 05 19 - Low-Voltage Electrical Power Conductors And Cables (600V And Less)*Revised May 2013*

Description: Building wire and cable with insulation rated 600 volts and less.

- A. Insulated wire conductors for circuit voltage 600 volts or less, shall be stranded copper, minimum size #12 AWG. Provide type THWN or THHN-2 wire and cable #4/0 AWG size and smaller in dry locations. Provide type THWN-2 wire and cable larger than #4/0 AWG size in wet locations. All conductor sizes shall be fully rated for the entire length of the feeder run. Conductors oversized for voltage drop may be reduced near the end of a conductor to allow termination at devices. Tap conductors from main feeder shall be reduced and allowed by the Code.
- B. All raceways shall be supplied with the proper NEC sized, green or bare copper, grounding conductor.
- C. All wire and cable shall be color coded as follows:

120/208 volt	480/277 volt
A-PHASE – BLACK	A-PHASE - BROWN
B-PHASE – RED	B-PHASE - ORANGE
C-PHASE – BLUE	C-PHASE - YELLOW
NEUTRAL – WHITE	NEUTRAL - GRAY
GROUND - BARE OR GREEN	GROUND - BARE or GREEN

- D. All wire and cable #8 AWG and smaller shall have color coded insulation or jacketing as noted above. Where the above noted colors cannot be provided in the wire and cable insulation or jacket, above #6 AWG, colored tape in the color designated above shall be placed on the cable at all exposed terminals, loops, and splices.
- E. When a 20-amp, single pole circuit for power and lighting exceed 100' for 120-volt circuits or 150' for 277-volt circuits from device to panelboard, use #10 AWG wire or larger as required to achieve a maximum 3% voltage drop at full circuit capacity.
- F. For all non-sinusoidal loads install a separate identified neutral conductor for each phase conductor. Conductors for non-sinusoidal loads shall be a minimum size of #10 AWG for 20-amp circuits.

Wire Terminations, Splices and Connections

- A. All connections to circuit breakers and switches and all terminations and splices in wires shall be made as noted below:
 - 1. For # 12 solid wire: Formed around binding post or screw.
 - 2. For # 12, #10 and #8 stranded wire: Proper UL approved lug, locking tongue compression lug, or approved connector on the breaker binding post or screw.
 - 3. For #6 wire and larger - Burndy "Qiklug" Type QDA, or approved equal, with round flange solderless lug, or connector on breaker (hex wrench or screw type lug). Circuit wiring connections to fixture wire shall be made with pressure-type solderless connectors such as Buchanan, Scotchlock, wire nut or approved equal.
- B. Splices in wires:
 - 1. For # 6 wire and larger – Use Burndy type QPR, or approved equal. For # 8 wire and smaller – Use Buchanan, or equal, pressure - type solderless connectors complete with insulator and security ring or "PIGTAIL" splices as described below.
 - 2. Splices for small wires shall be "PIGTAIL" splices with separate tails of correct color and size. There shall be at least 6 inch of tail left out of box after splice is made up.
 - 3. No splicing for smoke or heat detection or other fire alarm panel reporting devices. They must be directly connected to j-box terminals or panel relay terminals.
- C. Underground splices shall be limited and only with the approval of ASU Electrical Services Supervisor, and Capital Programs Management Group electrical engineer prior to installation.

26 05 29 - Hangers And Supports For Electrical Systems

Revised March 2010

- A. Supports, hangers, anchors, clamps, restraints and other components shall be supported from the building structural members and not from other support systems or non-structural elements, unless approved by ASU Electrical Services.
- B. Hangers and supports shall be approved standard design and shall be adequate to maintain the supported load in proper position and alignment under operating conditions.
- C. The use of powered driven fasteners (and shot pin) is strictly prohibited.

26 05 33 - Raceways And Boxes For Electrical Systems

Revised May 2013

General

1. All electrical wiring shall be placed in raceways.
2. No non-metallic cable (ex. Romex) or cords will be accepted in fixed installations. No BX, ENT, MC or similar product will be allowed.
3. In general, raceways are expected to be Rigid Galvanized Steel (RGS), Rigid Nonmetallic Conduit (PVC), or Electrical Metallic Tubing (EMT) conduit as noted in this section and shall follow the recommendations of the NEC for installation, use and protection. The use of Intermediate Metal Conduit (IMC) is not permitted.
4. Suspended lights and drop in lights in suspended ceilings may use 3/8 inch UL approved factory installed whips. Whips lengths shall not be more than 6 feet in length and use only with the approval on ASU Electrical Services on a job by job basis.
5. All conduit sizing will be in accordance with Appendix C of the NEC based on the conductor size, type and number. No conduit installed above ground will be smaller than 3/4 inch unless approved by the ASU Facilities Management Electrical Services. Exception: 1/2 inch conduit is allowed for a single circuit, 20A, 120V/208V drop down a wall for a dedicated device or piece of equipment. No conduit shall be less than 1" for underground installations, unless approved by the ASU Facilities Management Electrical Services.
6. All raceways shall be supplied with a 100% sized grounding conductor, and sized to the secondary loads.
7. Flexible steel conduit will be used only for chasing existing walls. Minimum size for steel flex conduit shall be 1/2.
8. Flexible steel conduit use in applications other than chasing existing walls shall have a maximum length of six feet, and shall be use only with prior authorization by ASU Electrical Service. 3/4" will still be the nominal size.
9. Underground conduits and ducts shall be enclosed in a concrete envelope. Trenching, back-filling and concrete work shall be done under this division of the work and meet 95% compaction.
10. PVC Schedule 40 shall be used for main power and telephone underground feeders. PVC Schedule 40 shall not be used above ground without approval of Electrical Services Supervisor.
11. Galvanized steel ELLS and sweeps shall be 36" minimum radius for 2" ~ 2-1/2" inch conduit diameter and 48" minimum radius for 3" ~ 5 conduit diameters and shall be used with all schedule 40 PVC conduit. All steel conduits will be half wrapped with an approved 20 mil tape for a total of 40 mil conduit coverage from ground level to the PVC.

SECTION 3: TECHNICAL GUIDELINES

12. PVC conduit may be used in concrete slabs or approved hazardous locations but shall not be used as stub ups.
13. Rigid steel shall be used in masonry, hollow tile wall construction and stub ups. PVC conduit shall not be used inside buildings, inside walls or above ceilings, without approval by the Electrical Services Supervisor.
14. Electric metallic tubing (EMT) May be used in furred spaces and in metal or wood stud walls, but not over 2" diameter in size. Where metallic tubing is used, connectors shall be water-tight, compression type, depending on location. **The use of Cast fittings will not be allowed.**
15. Conduits must be kept within the furring lines established on the architectural drawings, unless conduits are shown as exposed. Conduits 2" and larger shall be rigid galvanized steel unless otherwise approved by the Electrical Services Supervisor.
16. The contractor shall provide all necessary sleeves and chases required where conduits pass through floors, or walls. All sleeves shall be fire sealed in accordance with the fire rating of the wall or floor, and finish to match adjacent surfaces.
17. No conduit placed in a concrete slab shall have an outside diameter greater than 25% the thickness of the slab. No conduit shall be embedded in a slab that is less than 3-1/2" thick except for local offsets, and shall never be placed between the reinforcing steel and the bottom of the slab.
18. In office and academic buildings, no conduit shall be run in a concrete slab. These conduits must be run overhead, even where they serve only a dead end outlet. Exception: Underslab conduits will be allowed in existing classrooms that have slab-on-grade construction and that are being upgraded to current ASU classroom standards. All such underslab conduits shall be of materials, and installed ,per the most recent codes adopted by the University.
19. In dormitory type buildings, conduit may be permitted to run in concrete slab after a written request outlining specific design requirements is reviewed and approved by ASU Electrical Services.
20. All exposed conduits shall run parallel and perpendicular to building walls and ceiling.
21. Rigid galvanized steel conduit shall be installed where abuse or damage protection is needed.
22. Rigid aluminum conduit may be used upon specific approval from ASU Electrical Services, and shall conform to the following specifications:
23. Conduit shall be extruded from primary 6063 alloy to a temper T-42. Copper content shall not exceed 1/10 of 1%. Threads shall be cut true and shall be covered with petroleum base lubricant containing powdered zinc. Couplings shall be forged from primary 6063 alloy and shall be threaded and chamfered. Each length of conduit, elbow, bend and nipple shall be marked in accordance with UL standards.
24. All conduits shall be supported in an approved NEC manner on its own support system fastened directly to the structure without the use of power actuated tools, such as ram sets.

SECTION 3: TECHNICAL GUIDELINES

25. Conduit, 1" or larger, shall be supported with UL approved conduit hangers and two steel 3/8" all-thread rods, supporting a minimum 14" long unistrut trapeze.
26. Where conduit is supported from a wall, UL approved one or two-hole wall straps shall be used or UL approved conduit clips. Clips shall be a maximum of 6' apart.
27. Where multi-conduits follow the same run as piping, trapeze hangers (unistrut) may be utilized in common with other trades piping systems, with provisions made for proper spacing and the use of UL approved conduit clamps. Trapeze style hangers shall have two 3/8" steel all-thread rod supports for each section of unistrut, minimum. Unistrut shall be 1-5/8" x 1-5/8" minimum.
28. Suspending conduit from the bottom of the unistrut will be avoided when at all possible.
29. Conduit in caustic or corrosive areas or as directed by Electrical Services, will be PVC coated rigid Rob-Roy conduit with an enamel coating inside the conduit.

Boxes

1. All device, fire alarm, and special systems junction boxes shall be 4" square 2-1/8" deep minimum. All boxes in walls shall be securely fastened per the requirements of the code. All boxes shall be galvanized steel, **PVC boxes will not be allowed unless used in caustic or corrosive areas with prior approval of ASU Electrical Services.**
2. Blank cover plates will be clearly and legibility labeled on both sides with permanent marker indicating feeder panel and breaker identification. Labels shall be on machine printed tape. Use 1/4" wide clear tape with black lettering. Contractor shall submit proposed labeling system for approval.

26 05 53 - Identification For Electrical Systems

Revised May 2013

- A. All electrical equipment including, but not limited to switchboard and panelboards, motor starters, disconnect switches, relays, receptacles lighting and power panels installed, shall include locations of breakers feeding them by room and breaker number, and all apparatus used for the operation or control of power circuits, appliances or equipment, shall be properly and permanently identified by means of description engraved nameplate.
- B. Nameplate material shall be 3/32" thick engraved, laminated plastic or Micarta type with white letters engraved through the black background, except on emergency systems background shall be red and include the word "EMERGENCY." Letters shall be 3/16" high for devices, and minimum 1/2" high for equipment and enclosures. Nameplates shall be mechanically secured with self-tapping screws, bolts or rivets. Adhesives are not acceptable.
- C. Identify all motors and other pieces of electrically operated apparatus with 3/4" minimum height painted stencil lettering painted directly onto motor or apparatus. Color to contrast with background color.
- D. Equipment, boxes and enclosures containing conductors of systems 4160-volt and higher shall be provided with nameplates with a red plastic laminated nameplate with 2" high white core letters inscribed "HIGH VOLTAGE" in 1/2" letters. The nameplate shall contain the following information; Circuit Voltage, Circuit Number, and Circuit Source.
- E. Lighting and receptacle panel circuit breakers shall be identified by permanently fixed numbers such as individually engraved metal numbers, or numbers etched under an acrylic plastic sheet. **Stick-on-numbers such as "Tape Writer" will not be acceptable.**
- F. Panelboard shall have a type written directory indicating circuit numbers, equipment served and room number of the area served. Directory cards shall be edited and maintained during the course of construction to keep an accurate, up to date record of each feeder or branch circuit. Directory cards shall be installed in an existing directory holder or if not available installed under clear plastic in a suitable frame on the inside of door.
- G. All special outlets and remote control switches shall be identified by engraving descriptive markings on flush plates.
- H. All such nameplates or lettering shall be submitted to ASU Electrical Services before being secured or printed on the apparatus.
- I. All room number designations shall be reviewed with Capital Programs Management Group and the Office of the University Architect. Room numbering must be completed prior to typing the circuit directories since the room numbers on construction drawings may not agree with the ASU schedule of room designations.
- J. All receptacle cover plates and blank cover plates, shall be labeled and indicate the source panel and circuit breaker number. Labels shall be made with a "Dymo Rhino RO 5000 ®", or approved equal.

26 05 83 - Electrical Work Serving Others

Revised May 2013

- A. The contractor furnishing a piece of motorized equipment will furnish and install the motor. The electrical contractor will provide the wiring and make the connections.
- B. Line control devices will be delivered to the electrical contractor by the contractor furnished the motor, and the electrical contractor will mount and connect these items.
- C. Motor disconnect switches, circuit breakers, VFD's, will be furnished, installed, and connected by the electrical contractor where required.
- D. The control items, wiring diagrams, and the responsibility for correct installation and function of the control system shall be covered under that section of the work specifications where the equipment is specified to be furnished.
- E. The electrical contractor will run electrical conductors to a designated location near the controller and terminate in a disconnect switch or breaker of a specified size and type.
- F. Conduit and wiring shall be installed as required by this division for telephone, fire alarm systems, program clock system, TV antenna systems, telecommunication systems, emergency power, and central control system. Telephone systems as per ASU telecommunications Services.

26 09 13 - Electrical Power Monitoring And Control:

Revised March 2010

- A. An electrical watt-hour meter with demand register shall be provided. This meter shall be connected on the secondary of the transformer to meter all power consumption. The meter shall be located in an accessible space near the main distribution panel. For services over 200 amps, transformer rate meters are to be used: CT accuracy shall be calculated on the following, low range shall be 50% of service capacity and high range not over 100%. Accuracy class shall be for revenue grade metering as specified in C57.13 ANSI 0.3 and B0.5 burden (minimum) with continuous current thermal rating factor of 2.0. CTs shall be utility monitoring grade. CTs may be in the switchboard ahead of all connections or at the transformers, and must be readily accessible at either location. Provide a Superior test shorting block with a nonconductive cover to match campus standard behind the front face of the main switchboard metering section or at meter location. Bring all three potentials to the test shorting block. Meters shall be 3 phase, 4 wire meter with a neutral for 4 wire services. Meter shall have an LED display to six digits with kilowatt and megawatt indication. Watt-hour meter shall be a Pulse Initiator type, with a microprocessor base, self-contained. Designed to monitor and display all electrical parameters.

Approved Manufacturer: Cutler Hammer IQ-6600 series, billable quality meter, as approved by ASU Electrical Services.

- B. All meters will display all phase to phase and phase to neutral voltage, current per phase, total harmonic distortion, power factor, Var.'s, total watt usage, total kilowatt hours and megawatt hour indication. The meter will connect and communicate with existing Cutler Hammer Power Net system located in Central Plant.

NOTE: There are requirements for ASU's EMS system. See Division 25 51 00.

26 10 00 - Medium Voltage Electrical Distribution

Revised March 2010

Medium Voltage Duct Systems

- A. All primary voltage systems shall be in raceways, meeting the requirements of the NEC and ASU Electrical Design Guidelines and Standards.

Minimum Requirements:

- A. A minimum of two rigid galvanized five inch conduits and one spare 5" conduit shall be run from a designated source to the inside of each building. They shall be buried and concrete encased. PVC conduit beneath and exterior to the buildings with galvanized steel 90's and transition pieces may be acceptable.
- B. Concrete encasement shall be a minimum of 2500 PSI with an integral color tint (red).
- C. Concrete encased conduits shall be installed in pairs (i.e. multiples of two).
- D. A polypropylene pull wire (2500 lbs. PSI pre-lubed) shall be provided and installed in spare 5-inch conduit.
- E. All concrete encased duct systems shall terminate in an underground vault except where direct entry into building transformers or switches as permitted.
- F. Any primary voltage conduit run with over 180 degrees of bends shall require a vault or pull box. Any conduit bend of 15 degrees or more will be galvanized steel with 1/2 lap 20-mil tape for a 40-mil total thickness when installed in a duct as a transition or turn.
- G. All concrete encased ducts shall have a vinyl "DANGER HIGH VOLTAGE" warning tape buried in the trench parallel with the duct run and located 12 inches above concrete envelope.
- H. Primary Conduit inside buildings shall be 5" galvanized rigid steel with one spare 5" conduit supported at 5' on-center from the overhead structure. All bends and sweeps shall be rigid long sweep 48" radius type. Rigid conduit shall be by an approved manufacturer.
- I. Primary Conduit outside of building structures shall in each case be reviewed by ASU Electrical Services. The 5" conduit, with a 5" spare shall be 5" minimum in diameter. It may be Schedule 40 PVC in a concrete envelope with 48" radius galvanized steel elbows and sweeps.

Vaults

- A. Minimum vault size shall be 16' x 10' x 8' inside dimensions. Maximum spacing of vaults shall not exceed 320 feet from center to center.
- B. All roof loading shall conform to the State of Arizona Highway Specifications for H-20 loading.
- C. Vaults with switch gear or where switch gear may eventually be installed shall be 12' x 12' x 7'-6" high minimum inside dimension.

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- D. All vaults shall have top, walls, and bottom composed of reinforced concrete.
- E. Rings shall be made of gray cast iron or “hot dipped” galvanized steel. A machine finished cover set shall be provided to ensure a perfect joint between the frame and the cover.
- F. Vault covers shall be equipped with lifting handles and shall be 48-inch diameter minimum hinged lid traffic rated.
- G. Three horizontal runs of superstrut series #C300 or equivalent shall be embedded in each wall of the vault.
- H. Cable pulling irons shall be installed for each duct or future duct systems. Vaults shall be provided with a rock drain dump, with a sloped floor to a sump. A cast iron grating over the sump shall be provided.
- I. Each vault shall be equipped with a permanently installed hot dipped, galvanized steel ladder.
- J. Ladder rungs shall be spaced 12 inch on centers and shall be corrugated, knurled, dimpled, coated with skid resistant material or otherwise treated to minimize the possibility of slipping.
- K. Minimum ladder width between side rails shall be 12 inch. Side rails shall be a minimum 1 1/2 inch x 1-1/2 inch x 3/16 inch thick channel size. Ladder rungs shall have a minimum 5/8 inch diameter.
- L. The contractor shall furnish and install two 10-foot long chemical rods. The chemical rods EPA approve UL listed 40 year life expectancy will be installed horizontally at diagonal corners along the exterior of the vault with a minimum spacing of 10 feet between them. They shall be attached with Burndy HYGROUND crimp connectors to terminal points inside the vault and connecting to the ground ring inside the manhole. The penetration through the vault shall be sealed with link seal or equivalent following manufacturer's specifications.
- M. In each vault, furnish and install vertical cable rack risers (six for each wall).
- N. Risers shall be hot dipped galvanized, heavy duty, Hubbard #2225 with bolt fastening holes spaced at 25 1/2 inches. Mount racks to superstructure embedded in walls of vault. On each riser described above in each vault, furnish and install a heavy duty lock type hook, Hubbard #2233, 14 inch extension. On each hook furnish and install three maple insulators.
- O. Each unused duct bank running from a vault to a building shall be fitted with an approved cell plug fitted to make a watertight seal.
- P. Cells through which cable is installed shall be plugged with approved mastic and shall be watertight.
- Q. Unused corners of each vault shall be provided with a 16 inch x 16 inch thin wall block out for the future installations of additional duct banks.
- R. All switching or transformer vaults shall be constructed in accordance with the NEC.

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- S. A visible ground bus shall be established in all transformer vaults. Bond all metallic piping systems at one point. A buffer ground may be used in conjunction with chemical ground rods. Equipment access to all vaults shall be provided with openings large enough to remove and install equipment. A personnel door, a minimum of 48 inches wide 90 inches tall shall be provided into vaults accessible from the interior of buildings. The location of the personnel door must be such that access is possible to either switching or transformer vault. Each vault shall have all the lighting connected to the emergency lighting system; lighting shall provide a minimum of 50 foot candles. All lights shall be switched from inside the vault. Each vault shall have one duplex receptacle connected to the emergency system on dedicated 20 amp circuit. Ventilation shall be in accordance with the NEC requirements. Natural ventilation is desirable and forced draft ventilation shall be avoided.

26 12 13 - Liquid Filled Medium Voltage Transformers

Revised March 2010

- A. Liquid filled transformers shall be three-phase, 60 HZ, 65 DEG. C. temperature rise, liquid-filled, self-cooled, pad-mounted distribution transformers, rated at 45 KVA through 2500 KVA; medium-voltage 15,000 volts and below, for operation of three-phase secondary voltage, 480/277 and below with all four secondary leads brought out through insulated bushings.
- B. The primary side of the transformer shall be fused externally. Acceptable fuses stated. Bayonet fuse line - explosion type, drywell full range current limiting fuses.
- C. Transformers shall be manufactured in accordance with the latest revisions of applicable ANSI and NEMA specifications.
- D. Wound cores shall be of the five-legged design; stacked cores shall be five-legged design. The windings shall be copper.
- E. The transformer cooling and insulating fluid shall contain no PCB's and be environmentally safe enviro-temp, FR 3 or equal. This shall be stated on a permanent corrosion-resistant nameplate mounted in the low voltage compartment.
- F. Oil filled transformers shall have secondary containment capable of 150% of transformer oil capacity. Containment shall have a valve and nipple to allow for manual drainage.

Voltage Ratings

- A. Primary voltage rating shall be 12470 GR./7200 (95 KV BIL) Delta primary or as otherwise stated. Secondary voltage rating shall be (30KV BIL) minimum 208 Y/120 or 480 Y/277, or as otherwise specified.

Tap Ratings

- A. Transformers shall be furnished with TWO 2-1/2% full capacity taps above and below rated voltage center tap at rated voltage unless specified otherwise by ASU electrical services. The Tap Changer shall be ganged, externally operable with a standard hot stick, and suitable for de-energized operation only. The Tap Changer shall be set on rated voltage tap at the factory and shall be secured to prevent inadvertent change from this position. The operating handle of the medium-voltage Tap Changer shall be located above the low or medium-voltage bushings.
- B. New transformers shall have an externally operated load-break oil immersed rotary switch. Three one for "A" side one for "B" side and on for transformer.

Transformer Impedance

1. Transformer impedance shall be as follows:

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Transformer Rating KVA	%Z
75-225	2.0%
300-500	4.5%
750 – 3000	5.75%

2. The pad-mounted, compartmental-type transformers shall consist of the Transformer tank, medium-voltage cable terminating compartment, and the low voltage terminating compartment. All three of these components shall be assembled as an integral unit.
3. Provisions shall be provided for lifting the complete transformer with a margin of safety of at least five times the weight of the transformer without requiring additional hardware (bolts, etc.) for the attachment of slings or ropes. Construction of the unit shall be such that it can be lifted, skidded and slid into place on the mounted pad without disturbing the entrance cables. Suitable jack bossed or equivalent jacking facilities shall be provided on the tank. Vertical clearance for a jack shall be 1-1/2 inches minimum, 3-1/2 inches maximum. Transformer base shall be arranged for rolling in two directions: Parallel to and at right angles to the center line of the high-voltage bushing. The transformer tank shall be of sufficient strength to withstand a pressure of 7 PSI without permanent distortion. Bolt-on access handhold(s) or cover shall be provided on transformers rated 500 KVA and larger.
4. The finish shall be pad-mount green in color, Munsell 7 GY 3.29/1.5 and shall conform to the performance requirements of draft 6 of the proposed EEI finish guidelines for pad-mounted equipment. The contractor shall provide the manufactures certified test reports for the finish with the initial proposal. Further test results shall not be required unless the finish is changed in either application or method of composition. A stainless steel base to minimize corrosion shall be applied.
5. The transformer tank base shall be raised above the pad to protect the bottom finish during installation and to minimize corrosion due to moisture accumulation.
6. No portion of the tank or protruding appurtenances shall trap and hold water after submersion.
7. The nameplate shall be corrosion-resistant and mounted in the low voltage compartment.

Tank-Grounding

The tank-grounding provision shall consist of:

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- A. For 500 KVA and below; Two steel pads, each with 1/2 inch-13 NC tapped hole, 7/16 inch deep. Long enough to allow all conductors to be crimp lugged and bolted to ground bar.
- B. For 500 KVA and above; A minimum of two unpainted, copper-faced steel or stainless steel pads, 2 inches x 3-1/2 inches, each with the holes spaced on 1-3/4 inch centers and tapped for 1/2 inch NC thread. The minimum thickness of the copper facing shall be 0.015 inch. Minimum threaded depth of holes shall be 1/2 inch.
- C. Ground pads shall be welded on the transformer base or on the tank wall near the base, one in the high-voltage compartment and one in the low-voltage compartment. In the cases where the transformer tank and compartments are separate, provisions shall be made for electrically connecting them.
- D. Cooling fins shall be arranged so that partial covering by debris shall not materially hinder cooling.
- E. Each transformer shall be provided with two hold-down clamps for securing the transformer to the pad.
- F. A suitable marking inside the tank shall indicate the correct oil level at 25 deg. C temperature with an externally read liquid level gauge.
- G. The overall dimensions of the transformer, including cooling fins, shall be approved by ASU Electrical Services.

26 12 16 - Dry Type Medium Voltage Transformers

Revised March 2010

- A. Transformers shall generally be ventilated dry type, silicon resin encapsulation and process shall apply a four dip protective shield of silicon resin to the coils. Transformers shall be NEMA rated with 220 C. insulation. Primary transformers shall be an integrated assembly, including primary switching transforming and distribution sections. A minimum K 15 and shielded transformer should be used where non-linear loads of an unknown value is expected. All other K factors shall be designed to known loads with the use of supplemental surge arrestors. All nonlinear load transformers shall be shielded.
- B. Transformers shall be rated at 12,470V, at 95 BIL with 5 Tap 2-1 1/2% up and 2-11/2% down center tap at rated voltage 12470 from rated voltage on primary side. Generally, main power center transformers shall be dual rated and fan cooled with internally mounted fans controlled by a coil embedded thermocouple with a "MANUAL" - "OFF" - "AUTO" control switch mounted in face of the transformer cabinet.
- C. Transformers shall have a centigrade digital LED or LCD display temperature and fan control, indicating coil and core temperature, mounted on the face of the transformer cabinet oil type transformers are required under special conditions, their use, type and specifications will be approved by ASU Electrical Services.
- D. Main service transformers shall be bonded and shall have switches with fuse protection on primary and secondary sides.

High-Voltage And Low-Voltage Compartments

- A. High voltage terminal compartments shall be dead front construction, full-height, air filled compartments with hinged doors. They shall be located side-by-side and shall be separated by a steel partition.
- B. There shall be separate doors covering the primary and secondary compartments. The door covering the primary shall be capable of being bolted or padlocked, and these fastenings shall be inaccessible when the secondary door is closed. The secondary door shall latch at three points, and the handle shall be capable of being padlocked with a penta head bolt.
- C. Both compartment doors shall be equipped with stops for holding each door in a 90 degree open position. The stops shall be captive to prevent loss of the device and for convenience.
- D. The locking mechanism shall accept an American Lock Company series 5260 padlock with a 3/8 inch x 1-1/8 inch shackle.
- E. Doors on the high-voltage and low-voltage compartments shall be of sufficient size to provide adequate working space when open.

Medium Voltage Switching

- A. An oil-immersed rotary switch, rated at 200 amp, 300 amp, or 400 amp shall be supplied. The switch shall be a load-brake inside the transformer and load-make design and hook stick operable. Switches shall be for the following operation:
1. Radial feed units shall have 3 switch wired directly behind the primary bushings.
 2. Switching shall not allow for momentary de-energization of the unit
 3. **(4-position rotary switches allow for momentary de-energization and are not acceptable).**
- B. Loop feed units shall have three single LBOR switches (one for “A” side, one for “B” side, and one for transformer) and shall allow the following switching selections:

Switch A closed	Switch B closed	Transformer switch closed
Switch A closed	switch B closed	transformer switch open
Switch A closed	switch B open	transformer switch closed
Switch A open	switch B open	transformer switch closed
Switch A open	switch B closed	transformer switch open or closed

Bushing and Terminals

- A. The medium-voltage phase connection shall consist of externally clamped high voltage bushing wells rated at 200 amp or 600 amp dead break integral bushing and 200 amp load break inserts conforming to ANSI C57.19.01 and C57.1200 latest revision.
- B. Bushing inserts for transformers shall be rated at 200 amp at 15 KV, or 600 amp at 15KV.
- C. The medium-voltage winding neutral connection (Ho) shall be such that separation between "HO" and ground can be accomplished either by use of an internal connection, below oil-level, and a ground pad accessible through a handhold or through a primary bushing brought out below the primary bushing wells and grounded externally. If the high-voltage neutral is brought out through a bushing, it shall be located so it will not interfere with the primary cables. There shall be no permanent connection between Ho and Xo.
- D. A fully insulated, low-voltage neutral bushing shall be provided in accordance with ANSI C57.12.26, latest revision.
- E. Low-voltage line and neutral terminals shall be braced in such a manner that when the number of cables shown are connected, no structural problems shall develop.
- F. Low-voltage spades shall be copper or tin-plated copper. The dimensions and locations of the bushings shall be as indicated in ANSI C57.12.26, latest revision.

SECTION 3: TECHNICAL GUIDELINES

- G. The medium voltage bushing wells and low voltage bushings shall be replaceable in case of damage. Replacement may be either external or internal through a hand hole. External replacement shall be accomplished using normal hand tools (not special) and reasonable amount of force. Welded bushing wells are not acceptable.
- H. All units shall have provisions at the medium voltage entrance for attachment of a hold down bail.
- I. The calculated load on load breaks, bushings, and terminals shall not exceed 80% of the rated amperage.

Accessories

- A. The following accessories are required on all transformers:
 - 1. Load rated rotary switch, externally operated
 - 2. Pressure relief device
 - 3. Liquid level gage
 - 4. Top oil thermometer
 - 5. Cooling fans
 - 6. 1" drain with valve

Drawings, Specifications

- A. Each quotation shall include the following data, and all data will be guaranteed:
 - 1. All outline dimensions including appurtenances.
 - 2. A drawing of the proposed nameplate (complete with all data available at the time of the quotation).
 - 3. Rating of the transformer in KVA.
 - 4. Exciting current at 100 and 110% of the rated voltage.
 - 5. Excitation losses in watts at 100 and 105% of the rated voltage and 25 degree C.
 - 6. Full load losses in watts at 100% of the rated current and 85 degree C.
 - 7. Efficiency at full load.
 - 8. Percentage regulation at 1.0 PF and 0.8 PF.
 - 9. Percentage "IZ" of the transformer.
 - 10. Weight of complete transformer (including oil).
 - 11. Gallons of oil.
 - 12. BIL rating.

Tests

- A. The following certified tests and reports described herein shall be performed and documented with all test reports submitted to the ASU Electric shop within 30 days of shipment:
1. Ratio Test - phase relationship.
 2. Polarity
 3. Resistance
 4. Impedance voltage
 5. Full Load Loss
 6. Excitation Losses
 7. Core loss
 8. Exciting Current
 9. High Potential (where applicable)
 10. Induced Voltage
 11. Production Impulse Test
 12. ASU purchase order number and/or project number
 13. Serial Number
 14. KVA
 15. Voltage
 16. BIL
- B. A complete oil analysis shall be provided to establish a baseline.

Testing

- A. Insulation test shall be applied to all feeders and sub feeders. Such test shall be made with a "megger" capable of ringing through 50,000 OHMS and with a maximum applied voltage of 500 volts. The grounding system will be tested as a complete network with the cable connection to the water mains disconnected. Test point for the Network is to be in the approximate center of the side structure. Test procedure to be used is the "Fall of Potential Method" according to IEEE standards. According to this test procedure, two test rods are driven at 62 ft. and 100 ft. from the installation. Readings shall be taken on the grounding system by a third party testing agency. The cost born by the contractor must notify ASU Electrical Services 72 hours before the test. Submit a written report to the engineer and ASU for records. No new services will be turned on until all these tests are completed and deemed satisfactory. No ground which has greater than 5 ohms to earth will be acceptable by ASU Electrical Services.

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- B. After the installation is complete, voltage and ampere readings shall be taken at the mains of each panel with all connected equipment energized. Any phase unbalance shown from these tests shall be corrected by the contractor. All circuits shall be checked to insure that each circuit is connected to the proper neutral. Insulation resistance shall comply with N.E.C. All transformers shall be UL listed and meet all requirements of the ASA and NEMA. Upon delivery of a transformer to ASU, a copy of the certified manufacturer's routine tests, as outlined and prescribed by NEMA Transformer Testing Reports, shall be presented to the ASU Electric Services. All the tests performed by the manufacturer shall include, but not be limited to, the following:
1. Ratio test - Phase Relationship
 2. Core Loss
 3. Exciting Current
 4. Impedance Volts
 5. Load Loss
 6. Applied Voltage (High Pot Test)
 7. Induced Voltage
- C. The completed unit assembly shall be energized and checked completely for operation before shipment.

26 13 00 - Medium-Voltage Switchgear

Revised March 2010

- A. All medium voltage distribution equipment shall be rated at 5,000 volts or 15,000 volts minimum based on system voltage.
- B. All medium voltage switchgear (ACB's) shall be manufactured by Cutler Hammer or S&C (or equal), compatible with the ASU Central Plant distribution system. Sectionalizing switches shall be Cooper Vac-Pac, (all positions will be 600 amp rated; see Exhibit BB).
- C. Connections to switches shall be by standardized apparatus connectors (well bushing, bushing and cable connectors) as manufactured by Elastimold, Cooper, Raychem.
- D. Installation shall be in accordance with manufacturer's instructions. Each transformer's primary and secondary conductors shall be protected with fusing in all ungrounded lines using S&C or Cutler Hammer full height metal clad switchgear with S&C renewable fuses.

26 20 00 - Low-Voltage Transformers

Revised March 2010

- A. No transformers will be installed unless they are copper wound. Aluminum wound transformers **are not** acceptable.

26 24 00 - Switchboards And Panelboards

Revised May 2013

General

- A. Bussing of the switchboard should be of sufficient capacity to accommodate the next size larger transformer bank. Main breakers should be similarly sized.
- B. Buss bracing and Short Circuit Rating shall be for the calculated fault currents. If a calculated fault current is not known, the bracing and rating shall be a minimum of 65,000 AIC amps on any switchboard or panelboard.
- C. In each electrical distribution section shall be equipped with provisions for 25% additional space beyond that indicated in the schedules or on the single line diagrams for future use.
- D. Feeder to switchboard may be wire in conduit or "buss way". Wires in conduit where multiple conductors per phase are required, must be precut so all conductors per phase are the same identical length after connection. Current capacity of "buss ways" and the size of conduit for conductors shall be such that the next size larger transformer bank can be accommodated.
- E. Switchboards use as service entrance equipment (Main switchboards) shall be of dead front construction with the enclosure grounded. An interior ground buss and terminals are to be provided along with a jumper to the system neutral. All switchboards shall have a main breaker.
- F. Circuit breakers are to be used for protective devices including a main disconnect. Fuses will be avoided. Where fault currents warrant, current limiting devices are to be specified. All breakers are to be identified and a complete index provided.
- G. Main switchboards shall be convertible unit type, dead-front, dead-rear, totally enclosed, with Cutler Hammer, Square D, circuit breakers, or equal, as determined by ASU Electrical Services. With copper bussing only.
- H. All switchboards shall be tested by a third party to manufacturer and NETA specifications or supplied voltage plus one and a half time.
- I. Switchboards shall have main disconnects. Switchboards shall have metering with LED or LCD display and indicate phase to phase and phase to neutral voltage, current and wattage. All phases shall be supplied with a current and voltage metering connection to meter. On voltages 480 volts and less, no external potential transformers on the metering system will be permitted.
- J. Main switchboard supply feeders shall have a ground reference, with grounded conductor, back to the secondary side of the supply transformer.

Switchboards

Description: Freestanding sections 600-amp and greater for the distribution of power to large equipment and branch circuit panelboards.

26 24 00 - Switchboards And Panelboards

Revised May 2013

SECTION 3: TECHNICAL GUIDELINES

- A. Distribution sections are to be located in areas not generally open to the public. Main distribution sections are not to be located in areas of elevated temperatures or high humidity. Janitor rooms, utility closets for steam and water, air plenums, areas of elevated temperatures and humidity, areas of dust and locations exposed to the weather are to be avoided. Mechanical rooms that are cool, dry and dust free are satisfactory; a separate distribution section room is required.
- B. All sections shall be placed on a four inch high concrete base. Close proximity to the transformer vault is highly desirable. No water pipes or other system pipes, ducts, shall be run over or within 3 feet of any switchboard or switchgear.
- C. All switchboards and switchgear shall be front accessible with a main breaker or fused switch. Sections shall have Grounded deal fronts with front covers bolted to sectional frame to gain access to conductor and mounting devices.
- D. Distribution Section shall have a short circuit rating equal to or greater than the available short circuit current at the sections point in the system. Distribution sections shall be labeled with a UL short circuit rating and shall be fully rated. **Series ratings will not be allowed.**
- E. All loads and fault calculations are to be tabulated and indicated on the drawings as part of the panel schedules must be calculated not dependent on transformer let through.

Panelboards

- A. All busses will be copper and must be located in the rear of the panelboard cabinet.
- B. Interiors shall be completely factory assembled with bolt-on overcurrent devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
- C. Boxes shall be formed of galvanized metal, chemically cleaned, and breaks in galvanizing shall be painted with metallic aluminum paint. Minimum size shall be 20" wide by 5-3/4" deep unless noted otherwise. Trims and doors shall be chemically cleaned. Front door and trim shall be finished with ANSI #61 or 49 light gray paint for surface or semi-recessed mounting, and shall be finished with a prime coat for flush mounting.
- D. Provide a zinc primer factory finish on the exposed trim of flush mounted panels in corridors, offices and other public spaces.
- E. If the finish of the cabinet or front is damaged, scratched or marred during installation, and before acceptance of the work, the damaged surfaces shall be refinished on the job to the complete satisfaction of ASU Electrical Services.
- F. Power panelboards shall be dead front, totally enclosed, convertible type Cutler Hammer, Square D, GE, or approved equal and shall have a main breaker.
- G. Panelboard covers shall be calculated hinged with piano style hinges. (Hinge on hinge or door on door.)
- H. All panelboards shall have main breakers unless approved by ASU Electrical Services.

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- I. Panelboards shall not be series rated or feed through design.
- J. All panelboards shall have a short circuit rating and AIC bracing that exceeds the calculated fault current at the point in the system that the panel is installed. Calculations shall be made and submitted to ASU CPMG A/E Electrical Engineer and Electrical Services and indicate possible fault current. For existing panelboards, added circuit breakers shall comply with existing short circuit rating and AIC rating of the panel.
- K. In each electrical distribution panel, the contractor will provide a minimum of 25% spare breakers and spaces. A minimum of six spare breakers and four spare spaces must be provided.
- L. For flush mounted or other non-accessible panels, the contractor will provide one $\frac{3}{4}$ inch spare conduit for each three spare breakers and one spare conduit for each three spaces. In addition, the contractor will provide one spare one inch conduit for each 20 and/or fraction of 20 panel spaces counting all possible spaces in the panel.
- M. For panels of 200 amp capacity and over the contractor will provide one two inch conduit for each multiple of 200 amps or fraction over 200 amps. Stub conduits into accessible attics, above accessible ceilings or in location directed by ASU Electrical Services.
- N. All panels shall be labeled and a complete and accurate index provided inside the panel door. The index must be typed. This applies to remodeled areas as well. ASU room numbers shall also be indicated.
- O. All outdoor lighting panels (i.e., tennis courts, stadium, etc.), shall have HI magnetic breakers square D type QO130 HM, or as approved by ASU Electrical Services.
- P. All panels shall contain a ground buss.
- Q. All panelboards shall be keyed alike in each building, and attention must be given in this respect where new wings are added to existing buildings.
- R. Where the load supplied by a panel requires separate isolated grounding, the isolated ground conductor shall be sized to match the equipment grounding conductor and installed with all other conductors from the main panel, or transformer directly feeding panelboard. A separate isolated ground buss shall be provided in the panel and labeled.
- S. The contractor will provide a spare empty panel next to all new distribution panels for future use.
- T. ASU Electrical Services will review and approve all panel designations to assure conformance to a reasonable campus ID system. In general, panel identification shall follow a general form as follows:
 - 1. "By room number:"
 - 2. M - main distribution panel
 - 3. E - emergency lighting and power panels
 - 4. L - lighting panels i.e., 277/480V
 - 5. P - power panels i.e., 120/208V
- U. Combinations may be used such as:

SECTION 3: TECHNICAL GUIDELINES

1. ML - main lighting panel
 2. MP - main power panel
 3. ME - main emergency panel
 4. MCC - Motor Control Center
- V. Multiple panels are to be designated by room number sequence i.e., the first number to indicate the room, the following numbers are sequential letters, clockwise from entry door. Example: Panel L022B:
1. Type L = Lighting Panel
 2. Floor 0 = Basement
 3. Room 22 = Room Number
 4. Location B = Second panel from left
- W. Panels in corridors shall follow same sequence [i.e., L-C (0,1,2) (A,B,C...)].

26 24 19 - Motor Control Centers

Revised May 2013

- A. Starters should be grouped into motor control centers. Individual starters, except in isolated cases, are to be avoided.
- B. Motor Control Center(s) shall be 600 volt class suitable for operation on a three phase, 60 Hertz system, manufactured by Cutler Hammer, Square D, or GE.
- C. Motor Control Centers shall contain a main horizontal copper, silver-plated bus, with ampacity as required for the project, minimum 600 amperes. Vertical busses feeding units compartments shall be silver-plated copper and shall be securely bolted to the horizontal main bus. Joints shall be front accessible for ease of maintenance. The vertical bus shall be rated 50% of the main horizontal bus or 300 amperes, whichever is greater for front mounted units.
- D. Busses shall be braced for 65,000 amperes RMS symmetrical at 480-volts.
- E. A copper ground bus with a cross-section equal to at least 25% of the capacity of the main bus rating shall be bolted to sections and include terminal lugs.
- F. The enclosure type shall be in accordance with NEMA Standards for Type 12 with gasketed doors. Enclosing sheet steel, wireways and unit doors shall be gasketed.
- G. Wiring shall be NEMA Class II, Type B.
- H. Provide a separate source disconnect switch for each circuit brought into a starter or relay enclosure from a voltage source external to the starter.
- I. Starter units shall be combination type, with components and wiring readily accessible for ease of maintenance, connected to vertical bus by self-aligning connectors having free floating spring construction to insure positive silver-to-silver contact with both sides of bus.
- J. Thermal magnetic devices with solid state overload shall be provided to obtain specified short circuit rating.
- K. Provide three solid state overload units sized for the 125% of the motor nameplate full-load current rating.
- L. External operating handle of circuit disconnect shall be interlocked with door so handle must be in "Off" position before door can be opened, handle arranged for padlock either in "On" or "Off" position, with from one to three padlocks. Provide units with automatic disconnecting terminal boards for ease of removing units without loosening terminal connections.
- M. Each starter should have a hand-off-automatic (HOA) switch coordinated with the automation system.

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- N. All control power will be in the form of a control power transformer for each starter AND must originate within the cubicle of the MCC such that the removal of the cubicle or turning the cubicle master switch off will remove voltage from the control circuit. Transformer will be sized 150% of full load current of control circuit and starter inrush. Control voltage shall not exceed 120 VAC.
- O. Control and interlocks are to be coordinated with the automation system to maintain this requirement, with the exception of those systems controlled from the fire alarm panels for fan shutdown.
- P. Starters are not to be sized with the largest dip switch selectable heater at the running current value for the motor. Starter size must accommodate heaters 125% of the full running current of the motor. Heater elements shall be sized in accordance with the manufacturer's recommended size, based on the individual motor name plate rating or as recommended by the NEC.
- Q. Motor starters shall incorporate over current, over voltage, under voltage and phase lost motor protection. Starter using replaceable heaters shall not be used.
- R. Coordination regarding motors, starter control, interlocks and automation controls is necessary.
- S. Cross references to equipment lists and common equipment designations and identification is required on the drawings.
- T. Motor controls in Central Plant and all new buildings designed to be connected to the Powernet energy management system shall have a low voltage release instead of HOA and shall have a keyed lock or facility for a padlock.
- U. All motor control centers will have a monitor modular meter to display the total volt, amps and kilowatts with power factor and kilowatt hours. The unit will monitor and display each starter's volts, amps and cause of trip at the Motor Control Monitor and Powernet System.
- V. All Motors 60 horsepower and above shall be soft-start or variable frequency drive (VFD) controls. All motors starters shall be specified and provided for in the appropriate section of Division 26 – Electrical, unless provided as an integral part of the manufacturer's package equipment. Starters shall conform as follows:
 - 1. Three phase motors shall have full voltage magnetic across the line starters, unless a current limiting starter is specified. Thermal dip switch with selectable overload protection shall be provided on all three legs. Auxiliary contacts shall be provided as required for control interlocks.
 - 2. Equipment starters with control transformers shall have fuse protection on the secondary side of the transformer.
 - 3. Provide a start-stop membrane type push button switch in the control panel door except when an interlocking or automatic control device is needed, then Hand-Off-Automatic membrane type selector switch shall be provided in the panel door cover.

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4. Red and green LED or LCD illuminated status lights shall be included (green shall indicate "run").

26 27 26 - Wiring Devices

Revised May 2013

General

- A. Devices shall conform to NEMA standards, shall be UL listed and labeled, and shall be “Specification Grade” meeting the requirements of FS WC-596-F and switches meeting the requirements of FS WS-896-E.
- B. Wiring devices exposed to outdoors or wet locations shall be installed in “FS” or “FD” series conduits with weatherproof cast metal covers, and gaskets as required.

Receptacles

- A. Duplex receptacles shall be U-ground, rated for 125 volts, 20 amperes back and side wired with a thermoplastic nylon body. Receptacles shall be equipped with a full length steel back plate (strap).
- B. Duplex receptacles with ground fault interrupter characteristics shall be U-ground, rated for 125 volts, 20 amperes, Specification grade, feed-through type. Receptacles in bathrooms/toilets, within 6'-0" of a sink location, exterior outlets, utility vault, in set areas, and other locations shall be ground fault type.
- C. Single receptacles feeding critical, or high amperage loads shall be twist-lock type with cord cap to match.
- D. Approved manufacturer: Hubbell, Bryant, Arrow Hart, Pass & Seymour, or approved equivalent.
- E. All cover plates shall match the color of the electrical device.
- F. Where weatherproof mounting is required they shall be mounted in an FS box with Crouse - Hinds #DS 70 G cover, with gasketed spring type door for duplex receptacles, #DS10G for single receptacle, or Hubbell #5222 for duplex receptacles, Hubbell #5221 for single receptacle, Hubbell #7425 for power outlets, or approved equal.
- G. Receptacles will be 20 amp min. rating, industrial specification grade back and side wired with a thermoplastic nylon cover and body. Receptacle cover plates will be labeled indicating feeder panel and breaker identification. Labels shall be on machine printed tape 1/4" wide clear with black letters. Contractor shall submit proposed labeling system to ASU Electrical Services for approval.
- H. Armored cord grips and cord caps, where required, shall be provided for all special outlets in the amount of one cap for each special outlet.
- I. Contractor shall submit specifications on cord caps to ASU Electrical Services for approval.

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- J. No outlets or temporary electrical distribution shall be installed adjacent to or near water sources unless GFCI protected. All outlets or temporary electrical distribution on the exterior of a building or area that is exposed to the outside weather conditions must also be GFCI protected.
- K. The elevation of each outlet must be specified or indicated on the drawings.
- L. Receptacles and devices shall not be connected for feed through, but pigtailed in box for circuit continuation.
- M. Tumbler switches shall be flush mounted wall type tumbler switches and shall be silent mechanical type rated at 20 amperes, 120/277 volts AC Industrial grade with back and sided wired and with a nylon toggle.
- N. If more than one 20 amp single-phase circuit is installed in a conduit with a common neutral, the size of the neutral conductor shall be a #10 THW minimum.
- O. Cover plates shall be stainless steel or .040: brass with brushed chrome finish as manufactured by Bryant, or as approved by ASU Electrical Services. All cover plates shall be marked to indicate the supply panel and circuit number. Use 1/4" wide clear tape with black lettering.

Switches

- A. Switch locations for lights should be 48" above the floor, or as specified under ADA requirements. Cover plates for wall switches shall not be plastic. Stainless steel only, unless authorized by ASU Electrical Services.

26 28 13 - Fuses*Revised March 2010*

- A. Fuses shall be rated for proper voltage in which they are applied. Interrupting ratings shall be greater than the short circuit current available at the load side of the fuse.
- B. For motor, welder, transformers, capacitor banks (circuits with heavy inrush currents) type RK5 fuses shall be used. For all other types of loads type RK1 or type L fuses shall be used. For control circuit protection type CC (fast-acting) fuses shall be used.
- C. Safety disconnect switches shall be furnished and installed as a disconnecting means for all motors and equipment as required by Code or this standard.
- D. Safety disconnect switches shall be heavy duty, horsepower rated, quick-make, quick-break mechanism with visible blades, capable of switching 10 times the switch rating. Fuse pull out style will not be acceptable.
- E. Switches shall have a handle whose position is easily recognizable and is padlockable in the "OFF" position.
- F. Switches shall be furnished with cover interlocks with defeat mechanism for maintenance; fused where required.
- G. Switches shall be rated from 30 to 1200 amperes; 250 volts AC, DC; 600 volts AC; 2 or 3 pole; copper terminals; with manufacturer supplied ground bus.
- H. Switch enclosures shall be NEMA 1, general purpose where installed indoors; NEMA 12; dust-tight and oil-tight in industrial areas and NEMA 4X stainless steel where the disconnect switch is outdoors, or exposed to weather or in wet areas.
- I. Each switch shall have a mechanically attached engraved nameplate. Engraved nameplate shall include equipment designation (abbreviation and full name), normal or emergency power, voltage, phase, amperes rating of upstream feeder device and upstream panel as follows:

EX-1
EXHAUST FAN #1
NORMAL POWER
100A, 480V, 3-PHASE, 3-WIRE
FED FROM MCC4P CIRCUIT 4

26 28 23 - Enclosed Circuit Breakers

Revised May 2013

- A. Gutter mounted motor control center consisting of starters and fused switches are not considered desirable construction for a university building and must be approved by ASU Electrical Services.
- B. Circuit protection should be in the form of circuit breakers mounted in suitable panels with ON, OFF, TRIPPED indication.
- C. Disconnect switches shall be used where necessary at remote motor locations. Motor starting controls shall be centralized in a single motor control center if a sufficient number is involved and shall have illuminated "stop" and "run" indicators.
- D. Control centers shall be Square D, Cutler Hammer, GE or as approved by ASU Electrical Services.
- E. Only those with copper bussing throughout will be acceptable, rated at 65,000 AIC fully braced. Starters shall be UL listed for 3 million operations or more, with LED or LCD membrane type pushbuttons with off, auto, speed and run indication. All starters shall have dip switch selectable heaters in lieu of thermal overloads with overload trip class selection.
- F. All disconnects for starters shall have positive lockout in the "OFF" position.
- G. Motor controls in Central Plant and all new buildings designed to be connected to the Powernet energy management system shall have a low voltage release instead of HOA and shall have a keyed lock or facility for a padlock.
- H. All motor control centers will have a monitor modular meter to display the total volt, amps and kilowatts with power factor and kilowatt hours. The unit will monitor and display each starter's volts, amps and cause of trip at the Motor Control Monitor and Powernet System.
- I. All Motors 60 horsepower and above shall be soft-start or variable frequency drive (VFD) controls.
- J. All motors starters shall be specified and provided for in the appropriate section of Division 26 – Electrical, unless provided as an integral part of the manufacturer's package equipment. Starters shall conform as follows:
 - 1. Single phase motors shall have a manual starter with integral overload protection.
 - 2. Three phase motors shall have full voltage magnetic across the line starters, unless a current limiting starter is specified.
 - 3. Thermal dip switch with selectable overload protection shall be provided on all three legs.
 - 4. Auxiliary contacts shall be provided as required for control interlocks.
 - 5. Equipment starters with control transformers shall have fuse protection on the secondary side of the transformer.

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6. Provide a start-stop membrane type push button switch in the control panel door except when an interlocking or automatic control device is needed, then Hand-Off-Automatic membrane type selector switch shall be provided in the panel door cover.
7. Red and green LED or LCD illuminated status lights shall be included (green shall indicate “run”).

26 29 23 - Variable Frequency Drives

Revised March 2010

- A. Variable Frequency Drives (VFD'S) shall have a microprocessor based control system, high frequency IGBT semi-conductors or better. Pulse width modulated system and voltage vector control devices is preferred to supply full rated motor voltage control at rated frequency. Full motor performance without derating, with high efficiency is needed for both drive and motor. A diode-bridge rectifier and DC line reactor or AC choke is recommended to provide a high displacement power factor at all speeds and loads and to provide a low percentage of power line harmonics. VFD's shall have a minimum five year manufacturer's warranty.
- B. The VFD shall have a back light liquid crystal display with minimum 1/4 inch characters. The display shall indicate the setup, operation and monitoring of drive to be displayed, such as volts, amps, speed, frequency kilowatts and kilowatt hours with run, local or remote control indication. Acceptable units are ABB Cutler Hammer, Graham, or approved equivalent.

Operating Parameters

- A. Hand/Start will start the drive (assuming safety interlocks are closed) with the speed of drive controlled manually via "+" and "-" buttons.
- B. Off/Stop shuts down drive regardless of other commands.
- C. Auto/Start - drive will start and stop the drive via external contact closure. The speed is controlled via the building automation signal (4-20 mA, 0-10 volt DC, etc.).
- D. Program password to perform any change.

Setup Applications

- A. Factory program and start up shall be provided with a minimum five year parts, labor warranty, including travel time. This should initiate from time of startup.

Drive Features

- A. Current limit circuits shall be adjustable from 0-110% of the VFD's size factory default motor current.
- B. Constant torque start to allow constant torque start to full torque of motor on acceleration until drive reaches set point.
- C. Three phase output current measurement and software measures output on all three phases.
- D. The phase to ground is instantly detected and has an adjustable trip.
- E. The VFD shall have Integrated electronics, with thermal motor protection.
- F. VFD shall calculate the motor temperature based on current, frequency and run time, and allows for changing cooling conditions as speed and load vary.

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- G. The VFD shall have a DC line reactor to filter and reduce harmonics reflected back into the building power system.
- H. The VFD shall have voltage surge protection on the line side of drive.
- I. Acceleration and deceleration shall be used to shape voltage and current curves and should automatically be contoured to prevent drive tripping.
- J. The carrier frequency should employ IGBT's for high switching frequencies to prevent audible motor noise and to insure that motor current is practically sinusoidal.
- K. The VFD shall have critical frequency lockouts to avoid specific frequencies which cause mechanical resonance problems.
- L. The VFD shall have Built-in communications for direct communication to Johnson Metasys (N2) Landis & Staefa System 600.
- M. The voltage input for nominal + or - 10% adjustment should be from 200 through 240 volt range for 220 volt systems and 400 through 480 volt range for 440 volt three phase systems.
- N. The VFD shall have three interlock contactor bypasses with an hmcp 65,000 AIC breaker to insure that the drive power is removed from the VFD bus.
- O. A VFD drive lockable line safety selector switch to disconnect the VFD with a mechanical door interlock that is externally operable and can be locked out.

26 50 00 - Lighting

Revised May 2013

Lighting Limitations

- A. Arizona Revised Statutes Title 49, Chapter 7 places some limitations on outdoor lighting fixtures.
- B. **THESE PROVISIONS WILL BE ENFORCED.**
- C. All lighting must be designed with energy conservation in mind.
- D. Appropriate task lighting and light levels are listed in Section 26 06 50.
- E. Light fixtures in wet or damp locations, especially around bathtub and shower areas shall be installed such that water or moisture cannot enter any parts of the fixtures and shall be marked "Suitable for Wet Locations".

Lighting Intensities

- A. For general illumination of building spaces, the lighting design shall be based on this section and the latest edition of the IES Lighting Hand Book and IECC.
- B. It is suggested that general lighting be concentrated near chalkboards to give increased intensities on the chalkboards.
- C. In making lighting calculations due allowances must be made for the reflectivity of walls, ceilings and floors.
- D. Color schemes must be known before calculating design intensities.
- E. Provide switches for all lights except minimal night safety lights and lights on emergency lighting system. Hall lights will be keyed switches. Occupancy sensors shall be incorporated.
- F. Areas such as halls and large rooms with more than one exit should have three and four way switching.
- G. All light fixtures must be readily accessible for relamping.
- H. Fixtures in rooms that have obstructions such as lab tables or lecture furniture must not be higher than 12 feet above the floor or must have access from above for relamping.
- I. In clear level area high bay lighting over 20 feet must have access from above or some means of lowering the lights to 12 feet.
- J. Lighting accessible from above must have the appropriate catwalks, etc. to meet the requirements of ADOSH.
- K. All machine room, fan plenums, utility area pipe and air tunnels should have adequate lighting so a person can work on the machinery or utilities without supplemental light.

SECTION 3: TECHNICAL GUIDELINES

- L. Tunnels and fan plenums should have redundant lights so that one lamp failure will not completely darken the area. Light fixtures shall not be located above equipment or on high ceilings where re-lamping would be difficult. Circuits for these rooms and tunnels shall be from the emergency power panels and will be switched.
- M. Fixtures in staircase and entrances are to be located such that re-lamping does not require tall ladders, scaffolds at angles of ladders exceeding ADOSH limitations. In general, fixtures should be installed with eight feet as a maximum.
- N. Lights are in general expected to be fluorescent or LED. Incandescent, HID and HPS lights are to be considered only in special applications. Other lights may be considered only after review with ASU Electrical Services, and CPMG A/E and OUA.
- O. Fluorescent (2) lamp fixtures shall be of (4) foot T-8 and meet the color temperature and CRI guidelines per this section. Eight foot lamps and fixtures should be considered for special applications only.
- P. Other fluorescent lamps such as "U" tubes, low wattage for sake of shape or appearance, circle tubes or special colors will not be used or accepted, and will be removed at the DP's expense.
- Q. Fixture schedules are to be placed on the electrical drawings and not in the specifications.
- R. All fixtures are to have common stock ballasts that are manufactured for future design.
- S. This section includes general design parameters for conceptual calculation for electrical and lighting loads, in watts per square foot and foot candles.

Foot Candles	Watts per sq. ft.
Library reading rooms	50 - 1.0
Calculating rooms	50 – 1.0
Drafting rooms	75 – 1.9
Accounting rooms	50 – 1.0
Proofreading rooms	75 – 1.5
Classrooms	50 – 1.0
Laboratories	75 – 1.0
Seminar rooms	50 – 1.0
Offices	50 – 1.0
Shops	50 – 1.0
Toilet rooms	20 - 0.4
Kitchens	30 - 0.6

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Locker rooms	20 – 0.4
Store rooms	20 – 0.4
Corridors, Academic & Offices - 25, Dormitory	10 – 0.2
Stairs, Academic and Office - 25, Dormitory	10 - 0.2
Machine room	30 – 0.6
Building entrances, outside	30 – 0.6
Building entrances, inside	same as corridors
Parking Structures and Lots	3.0
General Site Lighting	1.5
Open parking facilities	2.0

- T. Supplemental local illumination shall be provided for wherever required to give the following local intensities:

Shop work at machines or benches	75
Displays	75
Demonstration tables or areas	60
Elevator Equipment Rooms	30

Lamps

- A. Incandescent lamps shall be inside frosted type unless otherwise specified. (Incandescent lamps should be avoided where possible)
- B. Fluorescent lamps shall be hot cathode, rapid-start or slim line standard cool white, and low mercury type.
- C. Only on projects with existing lighting will 34 watt energy saving tubes be used where 40 watt tubes are specified, except in dimming or outdoor applications.
- D. All lamps shall be new and operating at time of acceptance of the electrical work.
- E. Approved manufacturers are General Electric, Sylvania, or Phillips.

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- F. Lamps shall be type FO32T8 and 3500 Kelvin in color, low mercury type at ASU at the Tempe Campus, and other campuses as directed by Capital Programs Management Group.
- G. Lamps shall be type FO32T8 and 4100 Kelvin in color, low mercury type at ASU at the Polytechnic Campus.

Lamp Ballast

- A. Fluorescent lamp ballasts shall be the high power factor series type, CBM and/or ETL approved, and shall contain thermal protection, CLASS P for inside use.
- B. All ballasts shall be UL Listed (Class P) CSA certified and shall not exceed Class A ambient noise levels and shall have a classification of "Low Harmonics." Input current Total Harmonic Distortion content shall be 10% or below (expressed in percentage of full light output current levels) throughout the dimming range.
- C. Ballast shall have an average lamp current crest factor below 1.4.
- D. Ballasts shall meet minimum efficiency standards of Public Law No. 100-357,
- E. National Appliance Energy Conservation Amendments of 1988.
- F. Ballast shall withstand line transients as defined in ANSI/IEEE C62.41, category A.
- G. Ballasts shall have a power factor of 90% or above.
- H. Ballast shall not contain Polychlorinated Biphenyls (PCBs).
- I. Ballast shall meet the requirements of the Federal Communications Commission Rules and Regulations, Part 18, Class A.
- J. All ballasts shall be internally protected.
- K. Ballasts must be quiet operating and provisions must be established for removing and replacing any noisy ones.
- L. The noise level shall not exceed 34db when measured six feet from installed fixture.
- M. Specify premium construction ballasts for each type of fixture, by manufacturer, name, and catalog number. Energy saving electronic ballasts with 10% or less total harmonic distortion is required.

Lighting Fixtures

- A. Lighting fixtures shall be (2) tube energy saving type, and double switched for energy conservation and selected by the Electrical Engineer on the basis of the intended use of each space and any instructions which may be given by the DP.
- B. The fixture selection shall be checked and approved by ASU Facilities Management Electrical Services.
- C. Fixtures should be easy to maintain and replacement shades available from open stock.
- D. Where strip lighting is used, it is recommended that the rows be arranged parallel with any exposed ceiling beams.

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- E. Flush and recessed fixtures installed in furred ceilings shall be provided with junction boxes located at least one foot from fixtures.
- F. Wiring from junction Box to fixture shall be high temp. wire, as recommended by N.E.C., shall not be less than 4 feet, and not more than 6 feet of flexible steel $\frac{3}{4}$ " minimum conduit, but only in areas that are accessible from the space below ceiling. (The only Exceptions are UL listed Assemblies)
- G. In concealed locations, junction boxes shall be integral with fixture.
- H. Flush and recessed fixtures installed in concrete shall be wired with high temperature wire from the local control switch to the accessible junction box in the furred-ceiling area.
- I. Fluorescent fixtures shall incorporate a grid, screen, panel or other device which will prevent the falling of any tube which may become dislodged.
- J. All light fixture lens shall be acrylic plastic, minimum 0.125 inch thickness.
- K. Fixtures must be adequately supported to resist gravity forces. Wire, rod or support member shall support fixture from structure. Fixtures shall be secured as required by IBC.

Corridor Lighting

- A. Corridor lighting shall be on wired occupancy sensors to permit a person to enter the building at night and proceed through the building turning on lights ahead of themselves as they go.

Corridor lighting shall include a night light/emergency lighting circuit with a minimum of one lamp in each fixture, at each change of corridor direction. These lamps shall be connected to an emergency power source for buildings with emergency power panels.

26 51 00 - Interior Lighting In Unfinished Areas

Revised May 2013

- A. All unfinished areas are to meet code minimum lighting levels.
- B. All future finished space shall have power capacity and breaker space provided in the feeder panels and distribution panels.
- C. Telephone, automation and other signal raceways, including fire alarms serving unfinished but finishable areas, are to be complete through other finished areas.
- D. Attics and other spaces not finishable are not required to have these raceways except for the fire alarm system.
- E. Lighting in attics and service chases, etc. shall be provided.
- F. Switches are to be located at each access using three and four way switching where two or more accesses exist.
- G. All fixtures must be easily re-lamped, particularly in attics and mechanical chases without the use of ladders, hoists or scaffolds or catwalks must be installed.

26 51 13 - Exterior Lighting

Revised May 2013

- A. Exterior lighting must be for access and safety uses. Decorative lighting is to be avoided. Mall lights are to be of the campus standard type, metal halide type, per OUA Site Furnishings package that is submitted to each DP upon commencement of the project. All exterior lights are to be controlled from Central Plant through a latching relay and lighting contactors. **Photo cells, clocks or time commanders are to be avoided**, unless approved by ASU Electrical Services.
- B. Meet the following criteria:
 - 1. 3000 – 3500 Kelvin color temperature.
 - 2. Color rendition index (CRI): 70-85
- C. Can use:
 - 1. Metal Halide (MH)
 - 2. Compact fluorescent (CFL)
 - 3. LED
 - 4. High-pressure sodium (HP)
 - 5. High-output fluorescent (HO)
- D. Note that each lamp type has specific benefits and drawbacks. Careful consideration should be taken for each location and use.

26 52 00 - Emergency Lighting

Revised May 2013

- A. Emergency lighting systems shall be installed wherever required for reasons of personnel safety and per code.
- B. Review each installation with ASU Electrical Services on availability of emergency power from central plant.
- C. ASU Tempe campus has in place a 600 / 480 volt emergency power system throughout the tunnel system which is in the process of being upgraded to a 4160 volt distribution system and has selectively located 600 volt distribution panels.
- D. New buildings must be designed to get emergency power from the 4160 volt emergency power generator system installed at the Central Plant. Each building will have its own automatic emergency transfer switch (AETS). Normal power supply will be from the Service Entrance Section at the individual building and will be the primary, or normal, source or power to the AETS. The emergency power will be taken off of the emergency power distribution system grid supplied from Central Plant and will be connected to the alternate power source at the AETS.
- E. The emergency power system from Central Plant can be described as a quadrantized distribution system. The 4160 volt emergency power supplied from Central Plant is converted to a 600 volt emergency power distribution system at various locations in each quadrant on campus. All new installation to be 4160 to 48/277 to a distribution service sized at 60 of building loads. The 600/480 volt system shall be reduced to usable voltage for the individual building requirements ahead of the AETS. The AETS and the step down transformer will be located at each individual building.
- F. At ASU at the Tempe campus, emergency lighting systems shall be separate from normal lighting panels, but feed will be from normal power through transfer switching and backed up by central plant emergency distribution system.
- G. ASU at the Polytechnic campus has no emergency power system. Emergency existing lighting shall be designed utilizing a central emergency lighting inverter. Emergency lighting containing its own battery is unacceptable. Self-powered exit lights need approval from Capital Programs Management Group.
- H. Do not use battery operated exit lights or signs, or fluorescent battery DAC's for space lighting at the ASU at the Tempe campus.
- I. Use self-luminous exit signs whenever emergency lighting power is not available in the area.
- J. All exit lights and signs shall be on the emergency lighting system.
- K. Use long life LED lamps in all exit lights. Fixture shall have a cast iron housing.
- L. Exit signs shall be internally illuminated with red LED letters and a stencil face. Directional arrows shall be distinct and below the letters i.e. not triangles or mixed in the lettering.

SECTION 3: TECHNICAL GUIDELINES

- M. Battery operated emergency lighting may be used in small or special structures, that are not on the emergency grid, and with prior approval from ASU Electrical Services.
- N. All raceways for the emergency lighting systems shall be separate from all other raceway conductors.
- O. All central Emergency distribution panels shall be located such that they are accessible to qualified personnel only, such as in a mechanical room or electric switchboard room. Placement in janitor closets, halls, offices, classrooms, laboratories, storage rooms and closets is not acceptable.
- P. A minimum of 50 footcandles of lighting shall be provided in electrical vaults and at the main switchboards and motor control centers.
- Q. Both normal circuits and emergency circuits shall be provided in a redundant fashion.
- R. A dedicated 120 volt duplex outlet, rated at 20 amps, and on the emergency system shall be provided near the main switchboard and in the transformer vault along with normal circuits.
- S. Emergency lights are not to be switched, except in equipment rooms, tunnels, and vaults. Circuits are to be connected to the emergency panel board direct, with above exceptions.
- T. All emergency lighting circuits and lighting control diagrams are to be shown on the drawings.

DIVISION 27 – COMMUNICATIONS

27 00 00 - Communications

Revised May 2013

Description

The Telecommunication Design Guidelines are maintained by the ASU's University Technology Office. The latest revision can be found at the link below.

http://help.asu.edu/sims/selfhelp/SelfhelpKbView.seam?parature_id=8373-8193-4557

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

28 20 00 - Security Access And Surveillance

Revised March 2010

Description

During the initial phases of the project, the DP, along with the DPM, representatives from the User group, ASU Department of Public Safety (DPS), and the ASU Lock Shop(s) , shall assess the security needs of the project. Discussion shall include the project specific system, maintenance and service responsibilities of the individual system, and the system's interface with the owner's Central Reporting system to ASU DPS (where applicable). It should be noted that Call Center Services are becoming more common to "triage" for DPS.

This standard applies to door access, alarms and surveillance systems. All buildings will include an electronic door access system at all entries from the exterior, and for all laboratories as a minimum.

The Risk Assessment Checklist will be completed for all laboratories and will be used to determine the minimum security hardware for each of the laboratories. The Checklist is available from the DPM.

Programming

ISAAC may be used to control access at all exterior (zone) doors and at certain interior access control zones, such as specialty labs, computer labs, some office suites, some audio/visual equipment rooms, and other zones with specific access concerns.

To facilitate the implementation of ISAAC, certain programming issues need consideration during design. These include:

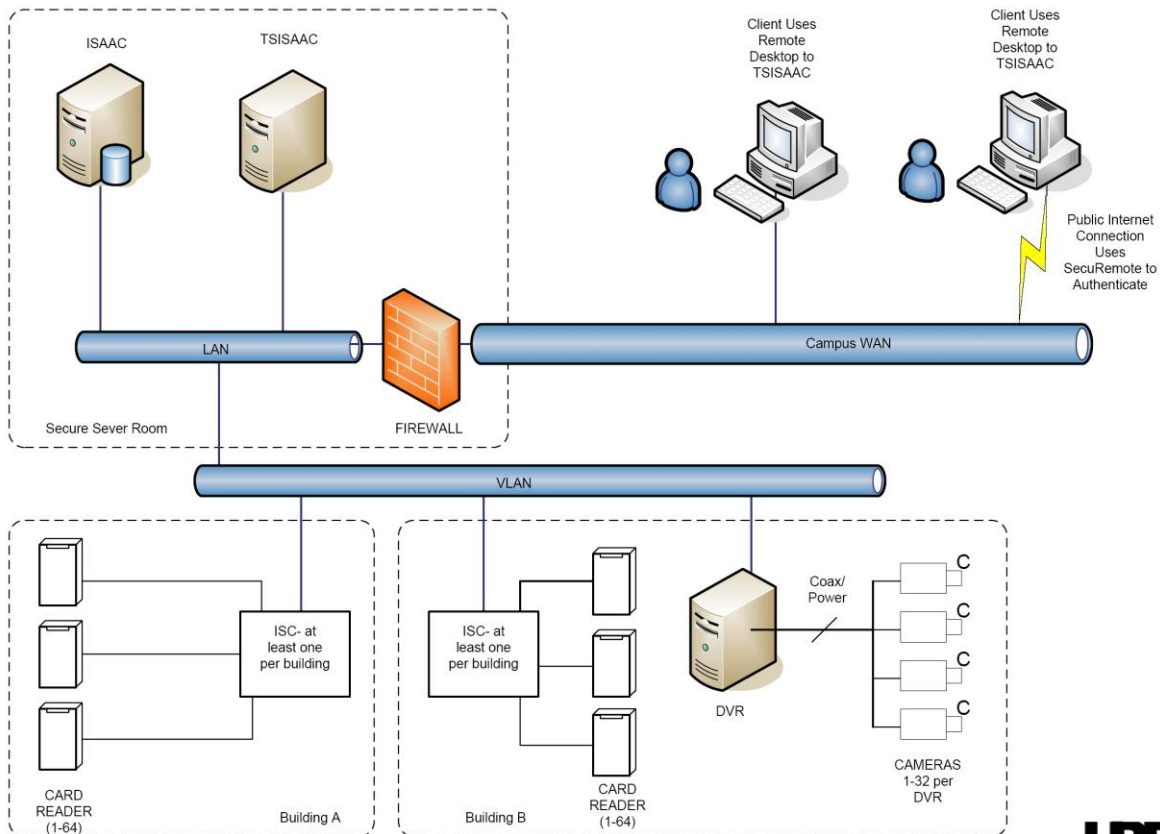
- Physical separation between public/non-public areas.
- Physical separation between different departments/operating units in the same building.
- Access during periods of time on weekends and after hours
- Conflicts between access control and life safety, i.e., egress, latching of fire doors.
- Conflicts between access control and ADA accessibility
- Minimum levels of security to be afforded to Specialty Laboratories

At a minimum, all exterior zone openings (doors) shall receive rough-in for ISAAC installation based on requirements determined during project Programming and Schematic phases.

The owner's vendors furnish and install some ISAAC equipment and wiring. Other equipment shall be by Contractor. The status of this equipment shall be determined during program conferencing.

Design Standards

- A. Risk Assessment Checklist: The risk assessment checklist, ASU form shall be used to discover and document the minimum level of security options for each laboratory. This assessment shall be initiated by the project coordinator and completed by the assessment team.
- B. Basic ISAAC Systems Architecture
The following diagram shows the major ISAAC components and how they are connected to each other. There is a separate diagram that provides more detail on the ISAAC and hardware wiring that is involved.



Henry Brothers Electronics, Phoenix AZ 480.894.2826

HBE

Note: Diagram Courtesy of Henry Brothers Electronics

Architecture Diagram Notes – The architecture diagram depicts the way that major ISAAC components work together at ASU:

1. A secure server room contains the ISAAC database & applications server and the TSISSAC server, which runs MS terminal server and the Lenel client software. These servers are on a LAN that is connected to the campus WAN behind a firewall.
2. ISAAC administrators, such as Segment Administrators, access the ISAAC database by using MS Remote Desktop to log in to TSISAAC. Once in, they log in to the Lenel client software that is running on TSISAAC. The number of clients that can be simultaneously be logged in to ISAAC is limited by the number of Lenel clients licensed and installed on TSISAAC. User computers may be connected directly to the campus WAN, or may access the campus WAN remotely through a public connection. User computers must be running SecuRemote.
3. A private ISAAC VLAN connects the ISAAC hardware (Intelligent System Controllers, DVR's, IP cameras) to the secure server room LAN.
4. There is at least one Intelligent System Controller (ISC) in each building connected to the ISAAC VLAN. Card readers are connected to the ISC's – up to 64 readers per ISC.
5. A Digital Video Recorder (DVR) server can also be connected to the ISAAC VLAN. Up to 32 cameras can be connected to each DVR via COAX and power lines.

C. ISAAC Database and Segments –

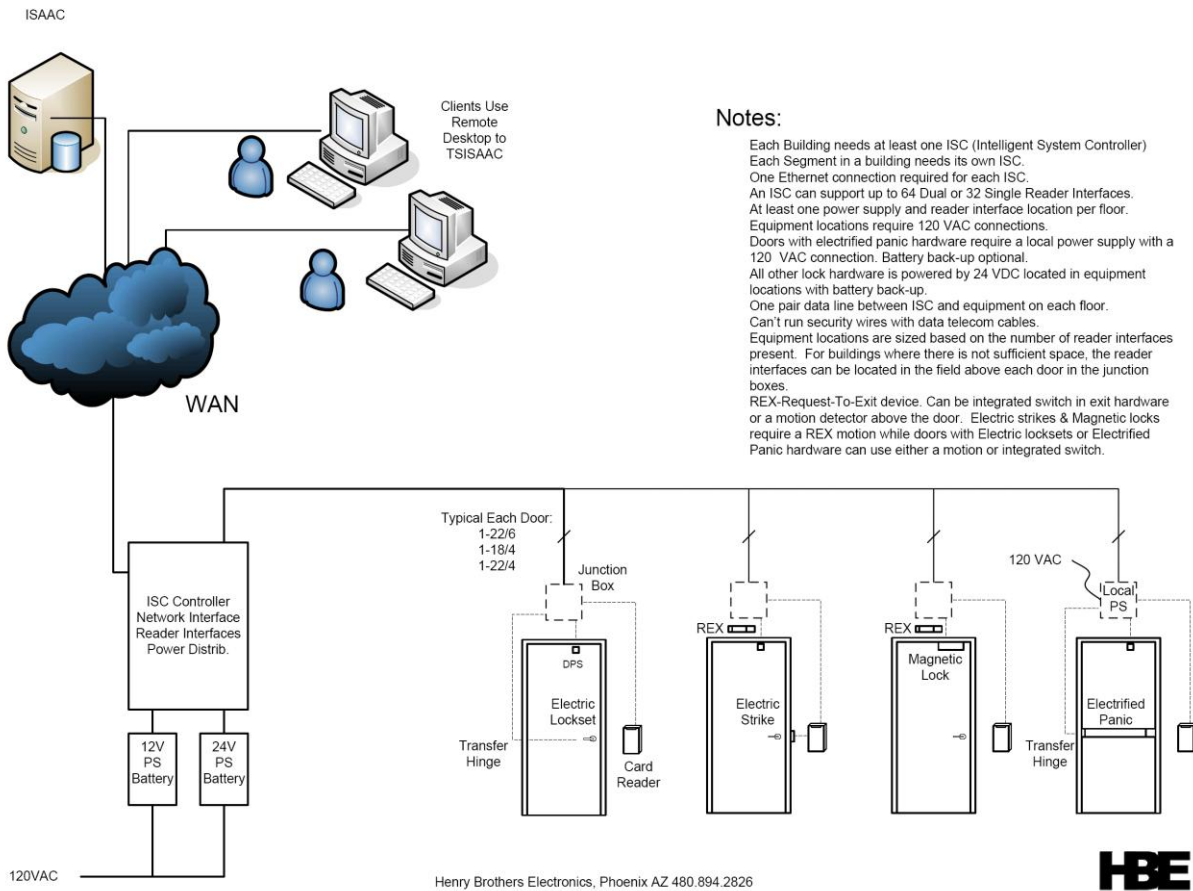
1. Software Standard: LENEL Software shall be “PRO” level standard or (better?)
2. Hardware Standard: HID I Class Smart Card and Smart Card Readers. All interfaces will have to be compatible with the (insert here)
3. ISAAC has a single shared cardholder database that contains information on all current faculty, staff, students, and those ASU affiliates who have an ASURITE userID.
4. ISAAC has a segmented database for information about readers and access controllers, schedules, permissions and relationships.

Note: Segmentation is the means used to allow a unit or group of units to control the spaces for which they are responsible – a segment is created for an area or set of areas that will be separately managed. There are ISAAC segments for some campuses, some colleges, some research group, for Lock Shop-managed areas, and so forth. Each segment name identifies the unit or group that has overall responsibility for its management. Information created and maintained in one segment is not visible from any other segment, although the overall ISAAC system administrators can see and deal with information in all segments.

SECTION 3: TECHNICAL GUIDELINES

5. Reader interface units cannot be split among segments, so readers that are physically connected (wired) to a particular reader interface unit must be all in the same segment. This might occasionally mean that there is a need to install more reader interface units than would be required in a non-segmented database, or to require a reader from one reader interface unit to another when responsibilities change.
- D. ISAAC Installation Planning – The ISAAC Systems Administrator Procedure document can provide additional procedural guidance to assist those who are responsible for major projects that will include installation of electronic access control. Following this design standard and the ISAAC specifications will help maximize efficiency installation of ISAAC. However, it is still best to coordinate projects with the Security Systems Sub Contractor from the design stage.
- E. ISAAC Typical Hardware Diagram

The following diagram shows the ISAAC server and remote client PCs connected to the WAN.



Note: Diagram Courtesy of Henry Brothers Electronics

1. The remote client PC's connect via TSISAAC. Also connected to the WAN is a box labeled: ISC (intelligent system controller), network interface, reader interfaces, and power distribution.

SECTION 3: TECHNICAL GUIDELINES

Connected to the ISC box are:

- a. A 12 V and 24V Power Supply (PS) battery. These are connected to 120V AC.
 - b. Doors with electric lock, electric strike, magnetic lock or electrified panic bar. Each door has a junction box or local power supply over it and each junction box or local power supply is connected to the ISC controller complex. Each junction box is also wired to a card reader next to the door. Typical wiring for each door is: 1 – 22/6 (one 22 gauge/6conductor), 1-18/4, 1-22/4.
 - c. The doors with the electric lock and the electrified panic bar show wiring through the door, through the transfer hinge, to the junction box or, in the case of the door with the electrified panic bar, to the local power supply. The door with the electric lock also shows a door position sensor (DPS) at the top that is wired to the junction box.
 - d. The doors with the electric strike and the magnetic lock have request to exit (REX) over the door.
2. Each building needs at least one ISC (Intelligent System Controller).
 3. Each Segment in a building needs its own ISC.
 4. One Ethernet connection is required for each ISC.
 5. An ISC can support up to 64 dual or 32 single reader interfaces
 6. At least one power supply and reader interface location is required per floor.
 7. Equipment locations require 120 VAC connections.
 8. Door with electrified panic hardware require a local power supply with a 120 VAC connection. Battery backup is optional.
 9. All other lock hardware is powered by a 24 VDC located in the equipment locations with battery backup.
 10. There is one pair data line between the ISC and the equipment on each floor.
- F. Surveillance Systems – Digital Video Recorders (DVR, Video Surveillance Systems etc...)
1. A private ISAAC VLAN connects the ISAAC hardware (Intelligent System Controllers, DVR's, IP cameras) to the secure server room LAN.
 2. There is at least one Intelligent System Controller (ISC) in each building connected to the ISAAC VLAN. Card readers are connected to the ISC's – up to 64 readers per ISC.
 3. A Digital Video Recorder (DVR) server can also be connected to the ISAAC VLAN. Up to 32 cameras can be connected to each DVR via COAX and power lines.
 4. All video surveillance systems will be compliant to DPS Policy 201–06: Governing Electronic Safety and Security Systems

G. Alarms and Alarm Monitoring

It is the responsibility of Capital Programs Management Group to ensure the ASU Department of Public Safety Crime Prevention representative reviews the security design.

Discussion shall include the project specific system, maintenance and service responsibilities of the individual system, and the system's interface with the owner's Central Reporting system to DPS (where applicable). It should be noted that Call Center Services are becoming more common to “triage” for DPS.

- H. Door Hardware – Install Adams-Rite Indoor Electric Strike Model 7140-510-628-00 24 VDC (or equivalent – voltage is most important) in the door frame in place of a normal strike. This usually requires cutting the frame to make it fit. A power source above the door is not necessary except for electrified crash bars – but avoid electrified crash bars if at all possible.
- I. Conduit and Electrical Specifications – Install ¾” conduit to an electrical duplex box in the wall next to the strike at ADA height, within a foot or so. Include a pull string. The duplex box should be roughly level with the strike. Conduit should extend to above the ceiling to a point where we can get at it to run wire into it. Drill a hole from behind the strike to the electric box to run the strike wires.
- J. Handicap Door Requirements - If the door has a handicap opener on it with a motor unit mounted above the door, be sure there is a ¾ inch conduit path from above the ceiling to the motor unit.
- K. Communications Closet
 - 1. There shall be at least one dedicated closet for the location of ISAACS related equipment. In multi-story buildings where ISAAC equipment is located above grade, there shall be a closet on each floor where ISAAC controlled doors are located.
 - 2. Identify and reserve an area of about 7 feet wide, floor to ceiling in a communications closet (IDF room) on each floor. Normally, doing this will require coordination with Information Technology. Mount ¾ inch plywood as backing board, if it is not already there. Allow a 3-foot clearance in front of the identified area for door swing.
 - 3. Install a 4-plex power on its own circuit into each IDF of each floor in the identified area, running the conduit down the right or left side boundary edge of the area. In other words, don't run the power down the middle of the area where we have to mount the equipment.
 - 4. If magnetic locks are used such that there are no crash bars, include a relay contact in the applicable data closet that closes when the fire alarm goes off so the mag-lock doors can be unlocked. The relay should provide both open and closed contacts.

SECTION 3: TECHNICAL GUIDELINES

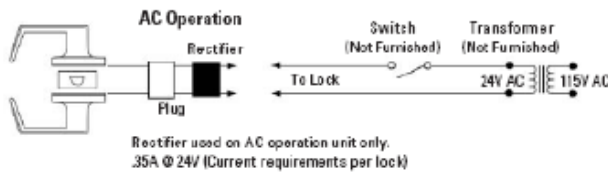
5. Select one floor, usually centrally located, to mount the primary intelligent controller(s) (64 doors each) and run one standard ASU Ethernet network connection to this location. IT Data Communications will configure this port to operate on the security VLAN: all communication between ISAAC system controllers and the ISAAC host will be on a VLAN.
- L. Wiring Requirements – Run two of each of the wiring types Belden 88760 and 9536 from the floor IDF to each door. This allows for extra needs such as door contacts or input sensors.
- M. Cabling Installation
1. All cabling shall be plenum and UL listed.
 2. All wall and floor penetrations shall be sleeved and fire stopped.
 3. All cabling shall be self supported with J-Hooks either from the wall or with self supported hanger wire.
 4. All vertical and horizontal pathways shall be 12 inches away from any voice/data cabling.
 5. Existing voice/data pathways will not be utilized for security door cabling.
 6. If the system controller is installed within a telecommunication room the space will be pre-approved with ASU Information Technology.
 7. The system controller location(s) will be denoted on the floor plan and will be mounted in a locked cabinet.
 8. The ASU Ethernet connection or connections required for the individual security system will be denoted on the floor plans.

N. Electrified Locks

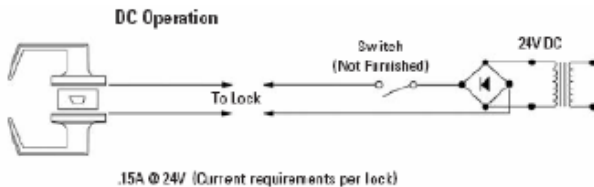
1. The A/E shall review all technical requirements of the proposed system with ASU DPS and ASU Electric Shop prior to design development.
2. D-Series locks are available for electrically locking and unlocking controls for high security and fire safety applications. They are UL Listed and rated for both fire and electrical single point locking on labeled doors. Refer to the lock function pages for functions and design availability.
3. Electrical Requirements: 24V AC, .35 amps or 24V DC, .15 amps.
4. Operating Temperature: Maximum +151 1/2F, Minimum -31 1/2F

Typical Wiring Diagram for Electrified Locks

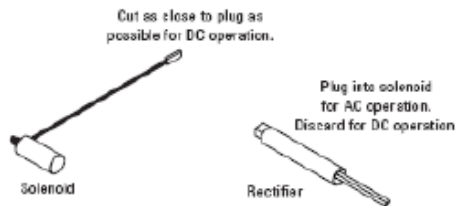
AC Power Source – EL or EU



DC Power Source – EL or EU

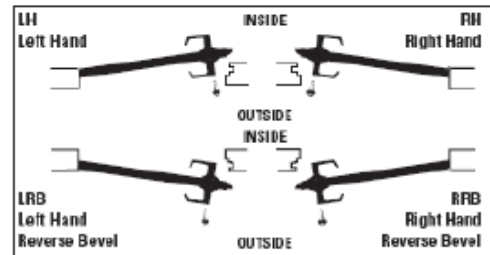


AC and DC Application



Door Handing

All Schlage® locks are reversible. Hand information is necessary to ensure proper finish of latchbolt and strike for split-finish locks. Follow the diagram to determine the hand of the door. The outside is the secure side or the corridor side.



Accessories

1-3/8" D-Series Lever Door Spacer



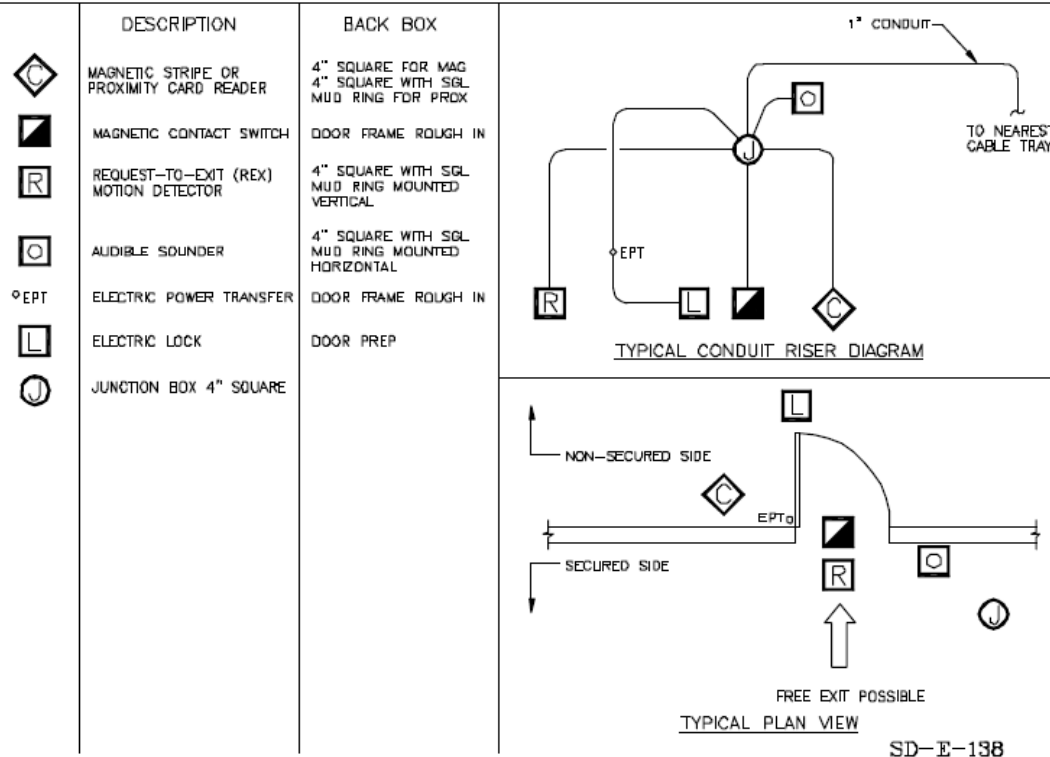
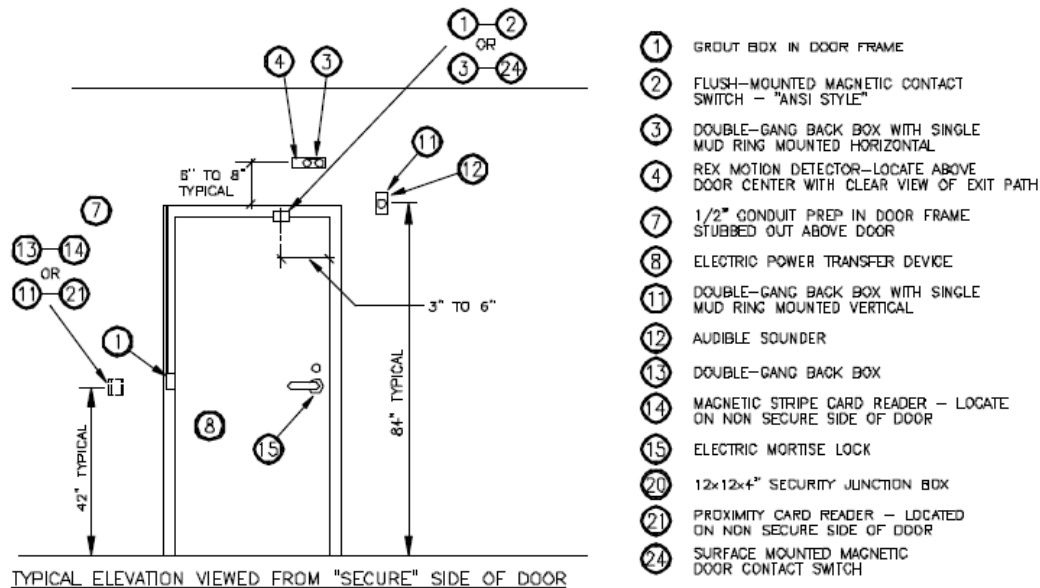
O. Latches & Strikes

SECTION 3: TECHNICAL GUIDELINES

1. Adjustable brass or bronze latch faceplates and strikes, furnished in compatible lock trim finishes.
2. Latch Bolt: Steel, 1/2" (12 mm) throw, deadlocking on keyed and exterior functions. 3/4" (19 mm) throw anti-friction latch available for pairs of fire doors.
3. Strikes: ANSI curved lip strike 1 1/4" x 4 7/8" (32 mm x 124 mm), 1 3/16" (30 mm) to center standard. Optional strikes, lip lengths and ANSI strike box available.

P. Standard Features for Lock housing

1. Cylindrical lock housing. Cold rolled steel, corrosion treated for normal atmospheric conditions
2. Key removable outside knobs for easy cylinder replacement
3. Solid brass 6-pin cylinders
4. No exposed mounting screws
5. Exceeds 800,000 cycle ANSI Grade 1 requirements by nearly 4 times (3,000,000 cycles)

Diagrams:**A. Typical Lock Installation of Door – Need Updated THIS IS ONLY AN EXAMPLE**

Typical Card Reader Controlled Single Door

28 30 00 - Fire Alarm System Codes And Standards

Revised May 2013

1.1 General

1.1.1 Summary - General

Drawings and conditions of the contract, including but not limited to General Conditions, and the Special Conditions listed below, apply to work of this section.

- Supplementary Instructions to Bidders.
- Supplementary Conditions.
- Summary of the Work.
- Project Coordination.
- Cutting and Patching.
- Definitions and Standards.
- Submittals.
- Schedules and Reports.
- Temporary Facilities.
- Security Regulations.
- Safety and Health.
- Products.
- Project Closeout.

Project Work/Identification

Project Name and Location: **(ASU BUILDING NAME)**

Owners Representative for this project is: **(ASU PROJECT MANAGER)**

Contract documents indicate the work of contract, and related requirements and conditions that have an impact on the project. Related requirements and conditions that are indicated on the contract documents include, but are not necessarily limited to, the following existing site conditions and restrictions.

1.1.2 Summary – Fire

This performance specification provides the minimum requirements for the Life Safety System. The system shall include, but not be limited to all equipment, materials, labor, documentation and services necessary to furnish and install a complete, operational system to include but not limited to the following functions:

28 30 00 - Fire Alarm System Codes And Standards

Revised May 2013

- Smoke and fire detection.
- Audible and Visible Notification.
- Campus Network Communication.

1.1.3 Project Representatives

All contacts with (**Project Name**) shall be directed to the Owner's Representative, hereafter referred to as the Owner: (**ASU Project Manager**)

For the purposes of this document (Section 28 – Fire Alarm System Codes and Standards), all references to “AHJ” shall be the Fire Code Official having jurisdiction over the project site.

1.1.4 ASU Required Vendor

Per RFP #171201 the fire alarm system shall be furnished and installed by awarded contractor **OR** as accepted by AHJ **AND** ASU's Fire Systems and Support Technologies Supervisor, when applicable.

1.2 References

1.2.1 General - Codes

All work and materials shall conform to all applicable Federal, State, local codes and regulations governing the installation including ASU Standards and Design Specifications. If there is a conflict between the referenced standards, federal, state or local codes, and this design specification, it is the bidder's responsibility to immediately bring the conflict to the attention of the Engineer, Capital Programs Management Group, and AHJ for resolution. System components proposed in this specification shall be UL listed to operate together as a system. **The supplier shall provide evidence, with his submittal, of listings of all proposed equipment and combinations of equipment. The supplier shall be responsible for filing of all documents, and securing all permits, inspections and approvals. Upon receipt of approved drawings from the authority having jurisdiction, the supplier shall immediately forward three sets of stamped drawings to the Owner.**

1.2.2 ASU Fire Systems and Support Technologies

Any alteration to existing fire alarm systems shall be verified, in writing, by the ASU Fire Systems shop supervision and/or Fire Marshal's office before the start of work.

1.2.3 Codes - Fire

The equipment and installation shall comply with the current minimum provisions or as otherwise stated as the most stringent of the following codes and standards:

- NFPA 70 - National Electric Code®
- NFPA 72 - National Fire Alarm Code®

28 30 00 - Fire Alarm System Codes And Standards

SECTION 3: TECHNICAL GUIDELINES

- NFPA 90A - Air Conditioning Systems
- UL 864 - Control Units for Fire Protective Signaling Systems.
- UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
- UL 268A - Smoke Detectors for Duct Applications.
- UL 521 - Heat Detectors for Fire Protective Signaling Systems.
- UL 464 - Audible Signaling Appliances.
- UL 38 - Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems
- UL 1971 - Signaling Devices for the Hearing-Impaired.
- UL 1481 - Power Supplies for Fire Protective Signaling Systems.
- IFC as adopted by the State of Arizona
- Americans with Disabilities Act (ADA)
- ASU Fire Alarm Systems and Design Standards
- ASUPD, ASU Fire Marshall & EH&S Design Standards for Mass Communication
- ASUPD, ASU Fire Marshall & EH&S Design Standards for Radio Communication
- ASUPD, ASU Fire Marshall & EH&S Design Standards for overall detection and evacuation (i.e. Manual Pulls, etc.)

1.3 System Description

1.3.1 General - Fire

The Contractor shall furnish all labor, services and materials necessary to furnish and install a complete, functional fire alarm system. The System shall comply in respects with all pertinent **codes, building permits, design specifications, rules, regulations and laws** of the Authority Having Jurisdiction. The System shall comply in all respects with the requirements of the design specifications, manufacturer's recommendations and Underwriters Laboratories Inc. (UL) listings.

It is further intended that upon completion of this work, the Owner will be provided with:

- Complete information and drawings (As-Built) describing and depicting the entire system as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system at a future date. Drawings need to be submitted as both a PDF and a DWG file, unless otherwise specified by the ASU CAD department.
- Complete documentation of system testing including air balance testing.

SECTION 3: TECHNICAL GUIDELINES

- Certification that the entire system has been inspected and tested, is installed entirely in accordance with the applicable codes, design standards, manufacturer's recommendations, and ULI listings, and is in proper working order. Contractor shall use "Fire Alarm System Certification and Description" as required by NFPA 72.
- Copies of panel and system programs delivered to the ASU Fire System's FTP site and on a flash drive to ASU's Fire Systems and Support Technologies group.

1.3.2 Description– Fire

Provide and install new fire detection and alarm system consisting of:

- Manual pull stations shall be located as shown on drawings, unless directed otherwise by AHJ. In addition, one manual pull station shall always be installed next to the FACP unless one already exists.
- Area smoke detection shall be provided as shown on drawings, unless directed otherwise by AHJ.
- Area heat detection shall be provided as shown on drawings, unless directed otherwise by AHJ.
- Beam smoke detection shall be located as shown on drawings, unless directed otherwise by AHJ.
- Duct smoke detection shall be provided as shown on drawings, unless directed otherwise by AHJ, and provide individual fan shutdown controls as shown on drawings, unless directed otherwise by AHJ.
- Provide audible appliances located throughout the building, as shown on drawings, unless directed otherwise by AHJ, and provide synchronized visual appliances located throughout the building, as shown on drawings, unless directed otherwise by AHJ. Speaker and/or horn strobes shall be installed in any mechanical room where mechanical devices, such as pumps, provide high levels of noise.
- Smokes shall be installed in all corridors and paths of egress.
- Pull stations shall be installed at any exterior exit point of a building unless otherwise stated by the AHJ.
- Provide supervised monitoring of sprinkler tamper and waterflow devices as shown on drawings, unless directed otherwise by AHJ.
- Provide primary and alternate elevator recall with the ability to auto-reset elevator upon FACP reset.
- Provide a primary and secondary means of communication for the FACP

- Primary shall consist of a fiber optic connection to the campus ASU Fire Systems fiber optic network. The Contractor shall be responsible for bringing in the new fiber from fiber hubs identified by ASU Fire Systems and Support Technologies and landing and terminating the fiber in LIU's next to the FACP. The Contractor shall be responsible for conduit from the Network FACP, to the LIU, thru to the nearest active network connection.
 - Secondary shall consist of 3 data drops on the Building Controls VLAN – part of the UTO network.
 - If NO data connections are available, primary and secondary communications shall consist of the use of an analog phone line.

1.3.3 Operations – Sequence of Operations

1.3.3.1 General - Audio

Upon alarm activation of any area smoke detector, heat detector, manual pull station, or waterflow monitor the following functions shall automatically occur:

- All newly installed systems shall be voice systems unless a variance is granted by the AHJ. All "A" occupancy buildings with an occupancy greater than 50 shall be designed for Mass Notification.
- If the AHJ decides against a voice system and issues a variance, the contractor shall install a future use speaker wire consisting of a #16 AWG white jacketed STP.
- The internal audible device shall sound at the control panel.
- The LCD Display shall indicate all applicable information associated with the alarm condition including: address, device type, device location and time/date.
- Any remote or local annunciator LCD/LED's associated with the alarm zone shall be illuminated.
- Activate audible and visual devices throughout the building.
- Transmit alarm signal to ASU designated monitoring stations (i.e. ASUPD and local campus alternate site) with point identification.

1.3.3.2 Duct Smoke Activation - Supervisory

The supervisory activation of any single duct smoke detector, the following functions shall automatically occur:

- The internal audible device shall sound at the control panel or command center.
- The LCD display shall indicate all applicable information associated with the supervisory condition including: address, device type, device location and time/date.
- Any remote or local annunciator LED's associated with the alarm zone shall be illuminated.

SECTION 3: TECHNICAL GUIDELINES

- Transmit signal to the fire alarm network workstations with point identification.
- Shutdown the local air handling unit only unless part of an approved smoke control system.

Note: The activation of two (2) or more Duct Detectors shall put the fire system into alarm, notify the monitoring station of a building alarm and shutdown all AHU's, as indicated on the Sequence of Operations Matrix (see below).

1.3.3.3 Trouble Operation

Upon activation of a trouble condition or signal from any device on the system, the following functions shall automatically occur:

- The internal audible device shall sound at the control panel or command center.
- The LCD keypad display shall indicate all applicable information associated with the trouble condition including; address, device type, device location and time/date.
- Transmit signal to the campus alternate monitoring site with point identification. ASUPD shall not receive Trouble alarms.
- Any trouble conditions received by the FACP will not be forwarded to the FAAP. The FAAP will only display Alarm and Supervisory conditions within the building.

ASU - FIRE ALARM SEQUENCE OF OPERATIONS MATRIX

First Issue: 24 August 2005
 Approved: 6 September 2005

	Initiate Audible & Visible Alarm Signal at FACP	Initiate Audible & Visible Alarm Signal at Annunciator	Initiate Audible & Visible Supervisory Signal FACP	Send Status Charge to Campus Network System	Activate All Horns & Strobes	Shut Down Affected Air Handler Unit	Recall Associated Smoke Damper	Shunt Trip Elevator Controller	Close Associated Fire Doors
Pull Station	X	X		X	X				
Sprinkler - All types - Also Includes other suppression systems such as Halon, FM200 and hood systems									
Water Flow/Activation	X	X		X	X				
Tamper/System Trouble			X	X					
Smoke Detector	X	X		X	X				X
First Duct Smoke Detector in Alarm Condition			X	X		X			
Second Duct Detector in Alarm Condition	X	X		X	X	X			
First Duct Type Smoke Detector for SFD operation in Alarm Condition			X	X		X			
Second Duct Type Smoke Detector for SFD operation in Alarm Condition	X	X		X	X	X			
Area Detector Used for SFD operation	X	X		X	X	X			
Heat Detector	X	X		X	X				
Elevator Lobby Smoke Detector	X	X		X	X		X		
Elevator Equipment Room Smoke Detector	X	X		X	X		X		
Elevator Shaft Smoke Detector	X	X		X	X		X		
Elevator Equipment Room Heat Detector	X	X		X	X			X	
Elevator Shaft Heat Detector	X	X		X	X		X		

This Sequence of Operations Matrix is intended to be a standard for ASU buildings such as classroom, office, recreation and library facilities. ASU realizes that specialty use buildings, such as laboratory and research facilities will require special needs and will be reviewed on an individual basis. If there are additional control functions required, they can be added on an individual basis.

1.3.4 System Configuration

1.3.4.1 General

All Life Safety System equipment shall be arranged and programmed to provide the early detection of fire, the notification of building occupants, and the activation of other auxiliary systems to inhibit the spread of smoke and fire, and to facilitate the safe evacuation of building occupants. All installed keyed devices, FACP, FAAP, NACPS and boxes shall be keyed to ASU's "CAT 30" keyway.

1.3.4.2 Secondary Power Supply

Standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for **sixty (60) hours** and capable of operating the system for **fifteen (15) minutes** of evacuation alarm on all devices, operating at maximum load. The system shall include a charging circuit to automatically maintain the electrical charge of the battery and supervise the integrity of the battery. The system shall automatically adjust the charging rate of the battery to compensate for temperature.

All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum

1.3.4.3 Display

The main display interface shall show the first and most recent highest priority system events without any operator intervention. All system events shall be directed to one of four message queues. Messages of different types shall never intermix to eliminate operator confusion. A "Details" switch shall provide additional information about any device highlighted by the operator. Provide manual by-pass switches for the following:

- AHU Shutdown by-pass
- Elevator Recall/Shunt Trip by-pass
- A/V by-pass
- Magnetic Door Holder circuit by-pass
- Smoke Damper by-pass

1.3.4.4 Initiating Device Circuits

Initiating device circuits monitoring manual fire alarm stations, smoke and heat detectors, shall be Class A, and will use #16 AWG yellow jacketed (unshielded)/STP/FPL solid copper wiring and shall be installed in a red EMT conduit, and a min 2 1/8" deep 4 square boxes. The installation of the conduit shall use compression fittings. In addition to the initiating device circuit, a green ground wire shall be installed in the same conduit run.

1.3.4.5 Notification Appliance Circuits

All notification appliance circuits shall be Class A, and will use a minimum #14 AWG stranded copper wiring and shall be installed in a red EMT conduit, and a min 2 1/8" deep 4 square boxes. The installation of the conduit shall use compression fittings. All notification appliance circuits shall have a minimum circuit output rating of: 2 amps @ 24 vdc. The notification circuits shall be power limited. For major remodels/ renovations and for changes to "A" occupancy, if an AHJ variance is issued for a system without voice annunciation, the contractor shall install a spare #16 AWG white jacketed STP for future voice addition. This wire shall be installed as one loop per floor and as a homerun back to the main FACP.

1.3.4.6 Signaling Line Circuits

- Each FACP will have 2 forms (Primary and Secondary) of independent communications to the ASUPD and the ASU Fire Systems and Support Technologies monitoring stations with event type identification. ASU Fire Systems and Support Technologies must be consulted in coordinating which type of communications will be acceptable.
- Primary communications shall consist of interconnecting to the dedicated ASU Fire System Fiber network using the protocol TCP/IP.
- The media shall be a (12) strand, 62.5/125 multi-mode armored fiber optic cable, Systimax #370-063-DSX-06 or equivalent
- Secondary communications shall consist of 3 data drops on the Building Controls VLAN.
- If neither form of communications is available, the use of an analog phone lines will be acceptable.
- At this time, the requirement for primary Fiber communications is only for the Tempe campus. Downtown, West and Poly all require phones for Primary communication until a Fiber infrastructure has been established
- When one form of communication has been lost, the second form must take over and transmit the signal.
- The loss of any form of communication must also trigger an alert at each monitoring system and send a corresponding Email.

The signaling line circuit connecting to addressable/analog devices including, detectors, monitor modules, control modules, isolation modules, and notification circuit modules shall be Class A.

1.3.4.7 Network Wiring

The system supplied under this specification shall utilize node to node, direct wired multi-priority peer-to-peer network operations. The system shall utilize independently addressed, smoke detectors, heat detectors and input/output modules as described in this specification. Each node is an equal, active functional node of the network, which is capable of making all local decisions and generating network tasks to other nodes in the event of node failure or communications failure between nodes.

1.3.4.8 Network Nodes

The remote control panel (network node) shall meet the same requirements as described in control panel section and shall contain the following:

- Integral power supply with secondary stand-by power.
- Signaling line circuits for communications with analog/addressable devices, as required.
- Notification appliance circuits, as required.

1.4 Submittals

1.4.1 Project

The contractor shall not purchase any equipment for the system specified herein until the owner, AHJ, Fire Systems Supervisor and engineer have approved the project submittals in their entirety and has returned them to the contractor. It is the responsibility of the contractor to meet the entire intent and functional performance detailed in these specifications. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications. The contractor shall submit six (6) complete sets of documentation within 30 calendar days after award of purchase order.

Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements of the contract documents. In addition the Contractor shall provide specific notation on each shop drawing, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.

All drawings and diagrams shall include the contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and stamped by PE (Fire and/or Electrical) or NICET IV signature. Any drawings requiring additional power need to have been calculated and stamped by an Electrical PE.

1.4.1.1 Requirements for State Fire Marshal Permit

1. Adding, replacing or upgrading 6 or more devices
2. Adding, replacing or upgrading the FACP, FAAP and/or NACPS
3. Adding, replacing or upgrading any fire alarm device connected to the HVAC system
4. All submittals shall be deferred and any reference to life safety devices in the construction documents shall be viewed as conceptual only.

These documents shall be submitted for review and permitting to the ASU's Fire Marshal's office, who represents the Arizona State Fire Marshal.

1.4.2 Product Data

Data sheets with the printed logo or trademark of the manufacturer for all equipment. Indicated in the documentation will be the type, size, rating, style, and catalog number for all items

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proposed to meet the system performance detailed in this specification. The proposed equipment shall be subject to the approval of AHJ, ASU FSST and the Engineer of record.

1.4.3 Shop Drawings

A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. This package shall include but not be limited to:

- Detailed system operational description. Any Specification differences and deviations shall be clearly noted and marked.
- Complete system bill of material.
- All drawings shall be reviewed and signed off by an individual having a PE (Fire and/or Electrical) or NICET IV certification in fire protection engineering technology, subfield of fire alarm systems.

1.4.4 Quality Assurance / Control Submittals

1.4.4.1 Installer's Certification

Must meet the requirements of RFP #171201

The engineered systems distributor must be licensed in the State of Arizona and have been incorporated in the business in that state for a minimum of 5 years.

Submit a copy of the system supplier's training certification issued by the manufacturer of the integrated life safety system, and a copy of the installing technician's NICET and/or an AHJ approved certification, such as the City of Phoenix CSA certification.

1.4.4.2 System Battery Calculations

Complete calculations shall be provided which show the electrical load on the following system components:

- Each system power supply, including standalone booster supplies.
- Each standby power supply (batteries).
- Each notification appliance and initiating circuit.
- Each auxiliary control circuit that draws power from any system power supply.
- All circuits are to be calculated at a 60 hour standby and with a 15 minute active alarm
- All calculations need to be stamped by an Electrical and/or Fire PE or NICET IV

1.4.4.3 Close Out

Three (3) copies of the following documents shall be delivered to the building owner's representative at the time of system acceptance. The close out submittals shall include:

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- Project specific operating manuals covering the installed integrated life safety system. The manual shall contain a detailed narrative description of the system architecture, inputs, notification signaling, auxiliary functions, annunciation, and sequence of operations, expansion capability, application considerations and limitations. Manufacturer's data sheets and installation manuals/instructions for all equipment supplied. A generic or typical owner's instruction and operation manual shall not be acceptable to fulfill this requirement.
- As-Built drawings consisting of: a scaled plan of each building showing the placement of each individual item of the Integrated Fire Alarm System equipment as well as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway. All drawings must reflect point to point wiring, device address and programmed characteristics as verified in the presence of the engineer and/or ASU fire inspectors unless device addressing is electronically generated, and automatically graphically self-documented by the system.
- All drawings shall be provided in standard DWG and PDF formats
- The application program listing for the system as installed at the time of acceptance by ASU FSST (FTP site update, electronic media, and all required passwords).
- Provide the name, address and telephone of the authorized factory representative.
- A filled out Record of Completion per NFPA 72.
- Provide final Building Permit signed off.

1.5 Quality Assurance

1.5.1 Qualifications of Contractor Fire

Per RFP #171201 the fire alarm system shall be furnished and installed by awarded contractor **OR** as accepted by AHJ **AND** ASU's Fire Systems and Support Technologies Supervisor.

1.5.2 Pre-installation Meetings - Requirements

The provider shall submit a detailed project plan that will describe in detail how the provider will approach the project, from inception to finalization. The plan must include at a minimum the following information:

- Project Staging
- Project Management
- Final Acceptance Testing

All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the manufacturer's riser/connection diagram and details for all specific system installation/termination/wiring data.

1.6 Project Conditions

It shall be the Contractor's responsibility to inspect the job site and become familiar with the conditions under which the work will be performed. Inspection of the building will be made as part of the pre-bid meeting.

A pre-bid meeting will be held to familiarize the Contractors with the project. Failure to attend the pre-bid meeting may be considered cause for rejection of the Contractor's bid. The minutes of this meeting will be distributed to all attendees and shall constitute an addendum to these specifications.

All work may be [unless otherwise noted] conducted during normal working hours, 8:00 a.m. to 5:00 p.m., Monday through Friday, by properly coordinating the work with Capital Programs Management Group. *Noise restrictions do apply!* The core drilling, testing of evacuation signals and other work disruptive to occupants will be prohibited between 6:00 a.m. and 6:00 p.m., Monday through Friday, and will be explained at the pre-bid meeting. Contractor is to include, in his base bid, all overtime necessary to complete his work. The Contractor shall be responsible for prior coordination of all work, demolition, and asbestos abatement with the Capital Programs Management Group (Asbestos Management Program for asbestos abatement).

1.7 Warranty and Maintenance

1.7.1 Spare Parts - Fire

The Contractor shall supply as spares, 10% of ALL Devices and a minimum of five (5) sets of (2) "Cat 30" keys shall be provided, appropriately identified, and turned over to ASU's Fire Systems and Support Technologies group.

1.7.2 Warranty

The contractor shall warranty all materials, installation and workmanship for two (2) years from date of acceptance, unless otherwise specified. A copy of the manufacturer's warranty shall be provided with close-out documentation and included with the operation and installation manuals.

The System Supplier shall maintain a service organization with adequate spare parts stock within 75 miles of the installation. **Any defects that render the system inoperative shall be repaired within 24 hours of the owner notifying the contractor.**

1.8 Training

The System Supplier shall schedule and present a minimum of 4 hours of documented formalized instruction for the building owner, detailing the proper operation of the installed System.

The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

Instruction shall be made available to the Local Municipal Fire Department if requested by the Local Authority Having Jurisdiction.

FIRE ALARM SYSTEMS PART 2 - Products

2.1 Manufacturer - Fire

The current RFP #171201 award winner shall be regularly involved in the installation, maintenance, and distribution of all products specified in this document. The products that are represented by the RFP Award winner shall be monitored under a quality assurance program that meets the ISO 9000 requirements.

All System components shall be the cataloged products of a single supplier. All products shall be listed by the manufacturer for their intended purpose.

Edwards Systems Technology, Inc. (EST3) products (as supplied by a licensed distributor to assure Campus Network compatibility) constitute the type of equipment to be installed unless otherwise approved by the AHJ **AND** ASU Fire Systems and Support Technologies Supervisor.

All control panel assemblies and connected field appliances shall be both designed and manufactured by the same company, and shall be tested and cross-listed as to ensure that a fully functioning system is designed and installed.

The system supplied under this specification shall be a mass notification ready. The system shall be capable of IP communications both Primary and Secondary as well as utilize independently addressed, microprocessor-based smoke detectors, heat detectors, and modules as described in this specification.

2.2 Panel Components & Functions

2.2.1 General – Fire

The control panel shall be a multi-processor based networked system designed specifically for fire applications. The control panel shall be listed and approved for the application standard as listed under the General section. The Panel shall be an Edwards [EST3] Network system installed in a **CAB-21 enclosure**, and all panels, and boosters including FACP shall be keyed CAT-30 for the Downtown, Tempe and Polytechnic campuses. West campus currently specifies the use of a mass notification ready Simplex base panel

The control panel shall include all required hardware, software and site specific system programming to provide a complete and operational system. The control panel shall be designed such that interactions between any application can be configured, and modified using software provided by a single supplier. The control panel operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.

The control panel shall include the following capacities:

- Support up to 2500 analog/addressable points.
- **Support multiple communication ports and protocols including TCP/IP**

SECTION 3: TECHNICAL GUIDELINES

- Support up to 1740 chronological events in the panel buffer.
- The network of control panels [nodes] shall include the following features:
- The ability to download all network applications and firmware revisions from the [FireWorks] computer at a single location on the system.
- Report to at least two separate FireWorks stations: ASUPD and each campus's local monitoring station – i.e. The Tempe campus has its station at USB.
- Provide electronic addressing of analog/addressable devices.
- Provide an operator interface control/display that shall annunciate command and control system functions.
- Provide a discreet system control switch provided for reset, alarm silence, panel silence, previous message switch, next message switch and details switch.
- Provide system reports that provide detailed description of the status of system parameters for corrective action or for preventative maintenance programs. Reports shall be displayed by the operator interface or capable of being printed on a printer.
- Provide an authorized operator with the ability to operate or modify system functions like system time, date, passwords, holiday dates, restart the system and clear control panel event history file.
- Provide an authorized operator to perform test functions within the installed system.
- Provide an authorized operator to perform [password protected] control bypass functions within the installed system.
- Fire alarm network workstation shall be able to access any local FACP functions.

The control panel shall contain a standby power supply that automatically supplies electrical energy to the system upon primary power supply failure. The system shall include a charging circuit to automatically maintain and supervise the electrical charge of the battery.

2.2.2 Operator's Interface - Annunciation

The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the building. Standard LED annunciators may be combined in common enclosures provided that the groups of LED's comprising each of the required annunciators are separated from one another (i.e. Alarm Detection, Supervisory, and Trouble Status) and clearly labeled. Note: **Any [remote] annunciators shall be programmed to annunciate alarm, supervisory and waterflow conditions only.**

Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel, and [*alarm signals only*] at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 85 db at 10 feet.

The annunciator shall contain the following system status indicators:

- 168 character Backlit Liquid Crystal Display

- System Normal Indicator
- System Common Alarm Indicator
- System Common Trouble Indicator
- System Common Supervisory Indicator
- System Ground Fault Indicator
- System Common Security Indicator
- System Disabled Point Indicator
- System Reset Switch with Indicator
- System Alarm Silence Switch with Indicator
- System Trouble Silence Switch with Indicator
- System Message Queue Scroll Switches.
- 10-Digit Keypad to Enable/Disable System and Functions.
- Location of microphone in remote FAAP's shall be determined by AHJ.

2.2.3 Primary Power Supply

- System power supply shall provide multiple power limited 24 VDC output circuits as required by the panel.
- Upon failure of normal (AC) power, the affected portion of the system shall automatically switch over to secondary power without losing any system functions.
- Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition.
- All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately annunciated as battery trouble and identify the specific power supply affected.
- All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.
- All AC power connections shall be to the building's **designated emergency electrical power circuit and shall meet the requirements of NFPA 72 - The AC power circuit shall be installed in a conduit raceway.**
- The dedicated power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside the each control panel or booster the disconnect serves.

2.2.4 Reports

- The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD display, and shall report to the main monitoring station, such as FireWorks.
- The system shall provide a report that gives a sensitivity listing of all detectors that have less than 75% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any particular detector.
- The system shall provide a report that gives a listing of the sensitivity of all of the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.
- The system shall provide a report that gives a chronological listing of up to the last 1740 system events in the panel buffer.
- The system shall provide a listing of all of the firmware revision listings for all of the installed network components in the system.

2.3 Field Mounted System Components - Fire Initiating Devices

2.3.1 Smoke Detectors & Accessories

2.3.1.1 Analog Addressable Smoke – General

Each analog addressable smoke detector's sensitivity shall be capable of being programmed individually as: most sensitive, more sensitive, normal, and less sensitive or least sensitive. In addition to the five sensitivity levels the detector shall provide a pre-alarm sensitivity setting, which shall be settable in 5% increments of the detector's alarm sensitivity value.

An alternate alarm sensitivity level shall be provided for each detector, which can be set to any of the five (5) sensitivity settings manually or automatically using a time of day event. In addition to the five alternate sensitivity levels the detector shall provide an alternate pre-alarm sensitivity setting, which shall be settable in 5% increments of the detector's alternate alarm sensitivity value.

The detector shall be able to differentiate between a long drift above the pre-alarm threshold and fast rise above the threshold. The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signal at 80%

2.3.1.2 Duct Detector Housing

Provide duct addressable duct detectors, such as or equivalent to EST Superducts. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Drilling templates and gaskets to facilitate locating and mounting the

housing shall also be provided. The housing shall be finished in baked red enamel. Remote alarm LED indicators and remote test stations shall be provided.

2.3.1.3 Smoke Detector - Photoelectric

Provide addressable photoelectric smoke detectors at the locations shown on the drawings. The detector shall have the ability to set the sensitivity and alarm verification of each of the individual detectors on the circuit. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds approximately six times an hour. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 80% of the allowable environmental compensation value.

2.3.1.4 Smoke Detector Guards

Where applicable, smoke detector guards shall be installed at the locations shown on the drawings. The guards shall be Underwriters Laboratories tested and listed by for use with the smoke detectors they protect. Guard design shall not affect the detector operating sensitivity and shall not reduce the listed detector spacing. The guards shall be constructed of 16-gauge steel with a baked white finish to match the detectors. Tamperproof mounting hardware shall be provided.

2.3.2 Detector Bases – Standard

Provide standard detector mounting bases suitable for mounting on North American 1-gang, 3 1/2 or 4 inch octagon box, min. 2 1/8" 4 inch square box, or European BESA or 1-gang box. The base shall, contain no electronics and support all series detector types.

2.3.3 Manual Pull Stations - Double Action Single Stage

Provide analog/addressable double action, single stage fire alarm stations at the locations shown on the drawings. The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature keyed Cat 30 shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering. The manual station shall be suitable for mounting on North American 2 1/2 (64mm) deep 1-gang boxes and 1 1/2 (38mm) deep 4 square boxes with 1-gang covers, and shall be mounted at the required ADA height.

2.3.4 Initiation & Control Modules

2.3.4.1 Relay Module

Provide addressable control relay circuit modules at the locations shown on the drawings. The module shall provide one (1) form “C” dry relay contacts rated at 24Vdc @ 2 amps (pilot duty) to control external appliances or equipment. The position of the relay contact shall be confirmed by the system firmware. Any module shall be 3 feet from the device.

2.3.4.2 Notification Appliance Circuits

Provide addressable notification appliance circuit modules at the locations shown on the drawings. The module shall provide one (1) supervised Class “A” notification circuit. The module shall provide polarized audible / visual selection for 24Vdc @ 2amps, audio outputs at 25Vrms @ 50 watts or 70Vrms @ 35 watts. Each NACPS shall have individual module supervised class “A.”

2.3.4.3 Isolation Module

Provide addressable fault isolator circuit with a minimum of 2 (two) per floor. The module shall be capable of isolating and removing a fault from a Class “A” data circuit while allowing the remaining data loop to continue operating.

2.4 Conduits and Raceways

Conduit shall be sized per code, but shall not be less than 3/4” unless preapproved by ASU. Exception: 1/2” conduits are allowed to be used as a run out to a single field device.

If surface raceways are required in finished areas, use beige colored Wiremold 2100. Coordinate locations with Capital Programs Management Group.

FIRE ALARM SYSTEMS PART 3 - Execution

3.0 Installation

3.1 Sequence

Installation of the systems shall be conducted in stages and phased such that circuits and equipment are installed in the following order:

1. Coordinate the location and size of all new access hatches with the Capital Programs Management Group and AHJ.
2. All fire system conduits must be in red EMT using compression fittings in a CLASS A configuration.
3. Wiring terminations are **device-to-device only. Splices and/or wirenut terminations are NOT acceptable.**
4. Pre-test the audible and visual notification appliance circuits by installing contractor.
5. Install all new detection devices.
6. Terminations between field devices and the associated control equipment.
7. Complete contractor pre-test of the entire system before ASU Fire Systems and Support Technologies are called into test the system.
8. Complete system testing with AHJ, installing contractor and ASU's Fire Systems and Support Technologies representative.

3.2 Special Installation Instructions

All installation procedures and methods are subject to inspection and approval from Capital Programs Management Group and AHJ.

The installing contractor **shall be** familiar with ASU standards and policies regarding work in occupied buildings.

Repeated offenses of ASU policies or failure to follow installation procedures and instruction from ASU Project Management will result in dismissal from the project and potential disbarment of the contractor from future work at ASU.

On-site storage of material will be coordinated with Capital Programs Management Group.

Access to locked rooms needs to be scheduled with Capital Programs Management Group a minimum of 24 hours in advance.

The awarded contractor is to field mark all areas where proposed conduit routing will affect asbestos. No cutting, coring, or drilling until the Capital Programs Management Group, Asbestos Management Program has the marked sights verified and abated (if necessary).

Consult with the Capital Programs Management Group regarding any questionable installation procedures or methods than may arise prior to proceeding. **Any work not performed per the**

NEC, ASU standards, and with professional workmanship will be removed and redone at no additional cost to ASU. If surface raceways are required, coordinate with Project Manager for an acceptable solution. .

3.3 Field Quality Control

3.3.1 Test & Inspection

3.3.1.1 Pre-Acceptance Test and Inspection

- All intelligent addressable devices shall be tested for current address, sensitivity, device location and user defined message.
- All wiring shall be tested for continuity, shorts, opens and grounds before the system is activated.
- The installing contractor shall provide instruments, tools and labor required to conduct the tests available. The person performing the tests shall be minimum NICET level II or CSA cardholder. The installing contractor shall also have the approved fire marshal plans and permit.
- All testing to the system shall be done in the presence of ASU's Fire Systems and Support Technologies.
- The system, including all its sequence of operations, shall be demonstrated to the Owner, his representative, and ASU's Fire Systems and Support Technologies department. **In the event the system does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the Owner, his representatives, and ASU's Fire Systems and Support Technologies department.**

3.3.1.2 Final Acceptance Test and Inspection

At the final test and inspection, a NICET level II or CSA cardholder from the installing contractor shall demonstrate that the system functions properly in accordance with these specifications in the presence of an AHJ, a representative from ASU FSST and the project GC (if applicable):

- Prior to any test by AHJ, a complete system with no troubles, supervisories, or alarms on the FACP (Green Panel) must be confirmed.
- Testing will be at the discretion of the AHJ in conjunction with the ASU's Fire Systems and Support Technologies crew.
- Stamped/approved plans and permit by the AHJ must be on site to review for testing and any alterations to approved plans must be pre-approved by AHJ. The AHJ is the immediate and legal fire safety professional.
- Copy of "as-built" drawings provided by the contractor prior to the scheduled time of test to be kept and used by ASU FSST and others at their discretion. A copy shall also be left on site in a designated "AS-BUILT" box installed next to the FACP.

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- A complete, accurate and up-to-date points list provided by the fire alarm contractor prior to the time of test showing each device address, type and location to be kept and used by ASU FSST.
- All trades involved with the fire alarm system (including but not limited to: building contractor, fire alarm contractor, elevator contractor, electrical contractor, mechanical contractor, fire sprinkler contractor, etc.) be present at scheduled time of acceptance test to provide all necessary time and material to test each and every individual device involved in the proper operation of the fire alarm system. Tests are conducted to confirm all required functions/operations of the system are compliant prior to final AHJ acceptance test.
- It is recommended that notice be given five business days prior to scheduling of acceptance test to alleviate potential scheduling conflicts involved in allocating time to prepare and conduct such test.
- A valid work order number with funds is necessary to cover the time and material involved in conducting the 100% acceptance inspection test.
- The representative shall provide technical supervision and participate in all of the testing for the system. All fire alarm testing shall be in accordance with National Fire Alarm Code, NFPA 72.
- A letter from the Contractor certifying that the system is installed entirely in accordance with the system manufacturer's recommendations and within the limitations of the required listings and approvals, that all system hardware and software has been visually inspected and functionally tested by a manufacturer's certified representative, and that the system is in proper working order. All documentation, software, or any other related items associated with the system shall be turned over to Capital Programs Management Group and ASU Fire Systems and Support Technologies.

DIVISION 31 - EARTHWORK

31 00 00 - Earthwork

Revised May 2013

Description

This section defines earthwork as rough and finish grading required to shape existing grades to design grades for sculptural effect, proper site drainage, lawns, shrub and ground cover beds. This section also includes criteria for building and site stormwater retention, which shall be confined on-site in retention areas, ponds, infiltration wells or as a final option, drywells.

The PM is responsible for obtaining a soils report that will become the guide for earthwork activities. A current report is required for all work.

Inclusion of the Soil Report in the specifications is not permitted on ASU projects. The report shall be made available to the engineers and contractor.

Earthwork shall be designed by appropriately licensed (Civil) engineering consultants. No attempt is made here to define the consultant's duties and responsibilities for normal professional practice. This guide identifies specific items of concern to the University that are earthwork related. The DP and his consultants are totally responsible for the adequacy of the design and contract documents.

All earthwork is to be designed to be in conformance with all applicable codes, ordinances and laws governing this work. The DP is to address appropriate regulations which may include the Arizona Pollutant Discharge Elimination System (AZPDES) Construction General Permit. To obtain coverage, submit a Notice of Intent (NOI) and Stormwater Pollution Prevention Plan (SWPPP) to the Arizona Department of Environmental Quality (ADEQ).

Dust control must be carefully defined in the contract documents

Design Standard

A. Fill

1. ASU is a long term building owner. Many projects have experienced site settlement long after the contractors have completed the projects. This settlement is a direct result of lax contractor practices and a lack of oversight during compaction processes. The DP will carefully define compaction parameters and practices. The DP will also have qualified personnel on site during compaction activities so that the specifications are met during construction activities.
2. The Owner will retain and pay for the work of testing agencies who will oversee (under the supervision of the DP) the contractor's compaction practices. The documents are to require the Contractor to immediately correct any inadequate practices or failed compaction areas.
3. This testing and observation applies to all areas of fill including trenching that may be discussed in other areas of these guidelines.

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B. Grading and Retention

1. Site grades shall direct site water away from all portions of the building, parking lots and walks at slopes that disperse the run-off at a rate that will not allow pooling or ponding.
2. The use of drywells should only be used as a back-up means of site water retention, and should not be relied upon to satisfy total stormwater requirements. ASU does not have a grading and retention design program for proper design and percolation requirements at present. Installation of any and all drywells require an ASU Building Permit It is preferred that the use on infiltration wells, microbasins and other sustainable measures be incorporated into the site grading and stormwater management plan.
3. The use of sump type pumps for exterior surface drainage is not allowable.
4. All areas to be planted with grass, ground cover or plantings shall receive a minimum of 12 inch top soil and the subgrade scarified to a depth of 6". See Landscape Guidelines
5. All finish grades shall be a minimum of 1/2 inch below adjacent walks, drives, curbs, mow strips and paving.
6. Any existing site area affected by rough or finish grading activity shall be restored to its original existing condition. Special care should be exercised in design to evaluate any affects new site work or building will pose on existing site features, plant materials, retention, travel, stormwater drainage, or aesthetics.

31 10 00 - Site Preparation

Revised May 2013

Description

This section applies to all new buildings, building expansions, utility expansions, parking structures, surface parking lots, Campus mall amenities, or any other design/construction activity that materially changes or effects the current features found on Campus. Areas incorporated in this section are civil surveys, archaeological studies and utility mapping.

Design Standard

- A. The DP will visit the site with the PM and representatives of various ASU departments to carefully review existing site conditions. The contract documents will identify any special features that are to receive special treatment.
- B. The DP will provide adequate direction for the protection and preservation of site elements to be retained. These may include constructed items and tree specimens.
- C. Items to be protected during construction must be clearly defined and the protection including watering is to be clearly stated. Include notes requiring the contractor to provide at no cost to the owner replacement elements in the event that the contractor allows items to become unusable during his construction process.
- D. The GC is to notify the PM a minimum of 72 hours in advance of any site preparation activity.
- E. ASU reserves the right to relocate, remove, or demolish any heritage tree, memorial tree, or special collection. This shall be coordinated with the PM, OUA and ASU Grounds.
- F. The contractor is to be required to carefully coordinate site preparation activities with ASU departments so that disruption to the campus environment is minimized. The DP is to carefully identify those departments with the assistance of the PM.
- G. The DP is to provide heightened awareness to the contractor that sub surface utility investigation at the University is a very serious issue. The DP and PM are to carefully define the various entities who will provide this exploration and mapping service.
- H. Subsurface investigation is to be conducted by properly licensed firms. On site and off site investigations are typically performed by different companies. The DP is to coordinate this carefully with the PM so that the documents reflect the correct entities for different locations.
- I. Archaeological clearances are necessary at all ASU sites. The DP is to carefully coordinate this aspect of the work with the PM.

31 23 00 - Excavation & Shoring

Revised May 2013

Description

This section includes consideration for any anticipated excavation support systems, including all underpinning, sheeting and tiebacks necessary to protect existing structures, workmen, general public, utilities, pavement, etc. during future project development and the construction process.

Design Standard

- A. No effort is made here to outline normal items that the DP and his consultants are to address in their specifications and drawings related to this activity. Only items of concern to ASU are outlined here.
- B. All areas to be excavated or shored must be barricaded or fenced from pedestrian or vehicular traffic;
- C. Excavated material not used for backfill of the project shall be transported off-site at the time it is excavated. Material used for backfilling may be stock-piled within the construction staging area (or other area deemed feasible by ASU);
- D. The contractor will have on site a full time safety officer during all excavatin and shoring activities. The safety officer will monitor all activies continuously so that the possibility for unforeseen difficulties is avoided. The safety officer shall provide his daily activity logs to the PM at the end of each working shift.
- E. Transport of all excavated material shall be coordinated with the CM, ASU DPS and the local municipality or jurisdiction. Special time-of-day restrictions in the transport of material may be necessary depending on the project, and should be specified and coordinated with the PM.

31 31 00 - Soil Treatment

Revised May 2013

Description

This section includes treatment of soils under buildings for termites and under paved areas for control of vegetation.

Design Standard

- A. Chemicals shall be EPA certified and approved.
- B. Termite treatment is required on new and alteration project under all footings, along foundation walls and under interior slabs on grade and exterior porch slabs.
 - 1. Chemical for termite pretreatment shall be Termidor SC or Premise.
 - 2. Chlorpyrifos based chemicals shall not be used.
 - 3. Mix solutions in accordance with Manufacturer's directions to highest concentration allowable by label.
 - 4. ASU will require a 5 year warranty for termite pretreatment on new work. Only those manufacturers that can comply with this warranty shall be specified. In alteration/addition work where 5 year warranty is not available, Contractor shall certify application rate.
 - 5. Contractors shall notify ASU Grounds 24 hours in writing prior to performing any termite treatment.
- C. Treatment for weed control shall be applied to soil below paved areas, both asphaltic concrete and Portland cement concrete flatwork, on open soil area and areas covered by decomposed granite.
 - 1. Application of chemicals shall not be harmful to the roots of adjacent plants.
 - 2. Chemical for weed control shall be "Surflan" pre-emergent.
 - 3. ASU requires a 6-month warranty for weed control on new work. Only those manufacturers that can comply with this warranty shall be specified.
 - 4. Weed barrier shall be used in areas covered by decomposed granite, and shall be woven polypropylene, (as provided by Arizona Bag Co. LLC or approved equal), which allows water to penetrate yet keeps weeds in check.

SECTION 3: TECHNICAL GUIDELINES

D. Arizona School Boards Association Reporting Hazards/Warning Systems:

1. Pest-control applicators shall provide the school contact person, through the General Contractor, with written or electronic notice at least 72 hours prior to the date and time the application of pesticides is to occur, including in such notice the brand name, concentration, rate of application, pesticide label, material safety data sheet, the area or areas where the pesticide is to be applied, and any use restrictions required by the pesticide label. Prior to the application, the applicator shall provide the school contact person, through the General Contractor, with a written pre-application notification containing the following information:
 - a. The brand name, concentration, rate of application, and any use restrictions required by the label of the herbicide or specific pesticide.
 - b. The area or areas where the pesticide is to be applied.
 - c. The date and time the application is to occur.
 - d. The pesticide label and the material safety data sheet.
2. The pest-control applicator shall fill out and make all required postings in accord with statute and with owner policy and regulation. The pest-control applicator shall verify owner requirements in adequate time prior to start of work to ensure that the project schedule is not impacted by the owner requirements.
3. The name and telephone number of the applicator shall be attached to any posting. Posting shall be made, at a minimum, at the following locations:
 - a. The main entrance to all buildings and rooms where pesticide and rooms where pesticide is to be applied.
 - b. Playing fields where pesticide is to be applied.
 - c. All main entrances to the school property and playing fields.
 - d. Any area that may be occupied in a period of seven or more consecutive days during which classes are not conducted on the school premises.
 - e. Immediately adjacent to any new construction areas where visible upon approaching the construction site.
4. Signs may be removed no less than 48 hours after the pesticide is to be applied, and shall be maintained in a legible condition.

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 12 16 - Asphalt Concrete Paving

Revised May 2013

Description

This section defines general design parameters for paving, curbs and traffic markings. The DP is required to obtain all information regarding parking stall layout, flow and stall dimensioning from Parking & Transit Services, ASU Department of Public Safety, CPMG (Accessibility Standards), Facilities Management (Best Practices) as well as any additional local, state or federal regulations governing this work.. The DP is to obtain formal written approvals of the design concept from these entities at the completion of the SD, DD, and CD phases.

All new AC pavement and AC Pavement maintenance design and specifying shall be performed by a properly licensed Pavement Designer/Consultant or a Civil Engineer. ASU requires that pavement be treated as an extremely important aspect of our infrastructure. Engineers who are tasked with pavement design must prove that the **specific individual** performing the design and specifying work **is a specialist** in this area. If that expertise is not available within the firm the consultant will be asked to retain the services of a suitable expert for these tasks.

Design Standard

New Pavement

- A. All new pavement design shall be based in part on a current soils investigation report. This report will be prepared by a qualified individual and sealed as an instrument of professional practice. The report shall make specific recommendations for the pavement types and sections that are used in these specific locations for the intended use.
- B. A pavement designer will design all new pavement and pavement maintenance system components.
 1. The Pavement designer shall be an independent consultant.
 2. In no instance will the pavement designer be affiliated with or an employee of a contracting firm performing pavement or pavement related work.
- C. The pavement designer will use the results of the soils report and his expertise in designing pavement sections adequate for their intended use.
 1. The pavement designer may exceed the recommendations that are made in the soils report as long as he has the knowledge and approval of the PM.
 2. In no instance is the pavement designer to design sections that are below the recommendations contained in the soils report.
- D. The University expects all pavement to have a useable life span of a minimum of 15 years.

SECTION 3: TECHNICAL GUIDELINES

- E. Parking stall layout, traffic circulation plans, signage and other necessary or required pavement accessories are to be designed and specified by a traffic control specialist,

Pavement Maintenance

- A. Pavement Maintenance will also be evaluated and designed by an independent pavement consultant or civil engineer in the same manner as described above.
- B. The consultant shall evaluate the condition of the area to be maintained and will quantify the defects encountered on a scale plan of the area.
- C. The defects will be identified as to type and the severity of the deterioration. These locations will be marked out in the field with a paint material that will remain visible for at least 30 days.
- D. The consultant will recommend the specific types of repair work that are to be performed: Crack Seal, Skim Coat, Slurry Seal, Seal Coat, Remove and Replace, Overlay.
- E. Each type of maintenance repair is to have a specification created that outlines repair materials and construction practices that are to be utilized during the repair.
- F. The consultants document is to be adequate for the purpose of obtaining bids necessary for the work.
- G. The consultant will specifically indicate aspects of the work that are adversely affected by various weather conditions expectble during the project. There are some types of work that simply are inadvisable during the hottest summer months.

Pavement Quality Control New And Maintenance Work

- A. The consultant will be retained to oversee the contractors materials, practices and procedures necessary during the pavement work.
- B. The consultant will review material specifications, transit tickets, to assure that materials are as specified. Nonconforming items will not be accepted and will be removed from the property.
- C. The consultant shall approve the commencement of work at each sequential step in the specified process.
- D. The consultant will be the judge of the necessity for soils testing or soil remedial activities that may include:
 - 1. Severely damaged or damp sub base
 - 2. Unknown conditions
 - 3. Requirement for overexcavation and recompaction of base course
 - 4. Any other defect that the consultant believes will degrade the installation.
- E. The consultant will issue a notice of completion of the work to the DP.
- F. The consultant will assist the PM in completing the contractor evaluation form.

Pavement Layout And Striping

- A. Parking ot striping shall be performed by a specialist in this area.

SECTION 3: TECHNICAL GUIDELINES

- B. Striping materials shall be specified by the DP and may be based on regional standards like the Maricopa Association of Governments (MAG) specifications.
- C. Striping and other marking paint is to last three years without recoating. The DP is to ensure that the specified materials and mill thicknesses are provided in the field.
- D. After the layout is marked on the pavement but prior to the application of the striping and marking paint, the PM, DP and/or Consultant are to all walk the area. They are to review the actual layout and ensure that it meets the design intent. Modifications may be made at that time based on the field conditions and the approval of the PM.

Miscellaneous

- A. No asphaltic concrete curbing or driveway aprons are allowable.
- B. It is recommended that a seal coat be applied after new pavement has aged for 12 months.
- C. Asphaltic concrete pedestrian walkways are discouraged at ASU. If approved by the PM, they shall conform to the same criteria cited above

32 13 13 - Cement Concrete Paving*Revised May 2013***Description**

This section includes all general concrete paving for pedestrian travel ways or entry features, that do not have special prominence dictating special design finishes. These installations are typically not designed and specified by an engineer or architect as a part of a larger project. On larger projects the DP is responsible for all aspects of the design and subsequent approval by the University,

This section specifically does NOT APPLY to any hardscape walks that are a part of the University wide fire safety system or walk ways that will be used regularly for vehicular traffic or cart access. Cement Pavement for these types of uses are to be designed by the appropriate engineers to their criteria, standards and quality control.

Design Standard

- A. 8' design width in areas of low pedestrian travel, 10-12' design width in areas of high pedestrian travel, including collector walks at residence hall buildings. Paving continuing or connecting major mall travelways (i.e., Tyler Mall), or major/significant building entries shall be of a width justified by traffic volume and aesthetic precedent.
- B. All curb cuts, ramps and level transition shall conform to applicable governing standards including the Americans with Disabilities Act.
- C. Sidewalks that are 5 feet in width or wider should have 6 inches of concrete over 4 inches of base course that has been compacted to 95%.
- D. Medium broom finish, perpendicular to the route of travel unless otherwise noted. Integral color, acid etched, exposed aggregate and/or sandblasted finishes are acceptable and need to be approved by OUA.
- E. Expansion joints 20' maximum in a single run of paving.
- F. Architectural scoring or joints to be at the same interval as the design width of the subject travel way. Designers option for widths greater than 8', or walks requiring special design consideration.
- G. An additional 3' of width is required for walks that are adjacent to surface parking lots, where the edge facing parking is used as a wheel stop or overhang area.
- H. Walk intersection corners shall be rounded and at all grade changes shall have appropriate curb cuts and transitions that allow full handicap accessibility and safety.
- I. A minimum 12' radius turn-around area is required for any dead-end walk.
- J. Walks over 8' in width, adjacent to grade changes of over 4 inch, adjacent to planter beds, walks crossing of vehicular travelways, special entry features or major mall connections or extensions shall also consist of a border/curb design as described in Division 03, Section 03 35 23.

SECTION 3: TECHNICAL GUIDELINES

- K. Minimum parking stall size is 8'-6" x 18'-0", handicap accessible stalls shall be per ADA.

32 13 16 - Decorative Concrete Pavers

Revised May 2013

Description

Stone or special concrete material pavers set on grade that are intended primarily for pedestrian areas.

Design Standard

- A. Designs using pavers must be approved by the proper ASU departments.
- B. Pavers are to be manufactured natural or cast concrete units designed for pavement use.
- C. Edges abutting another material (landscape, building walls, etc) shall be mud set on a concrete waste slab/footing that is a minimum of 12 inches wide and 6 inches deep. A continuous #4 rebar is to be installed in the mid-depth of this concrete to limit cracking and movement of the border.
- D. The preferred method of setting pavers is thick mortar setting on a 2" thick concrete waste slab. The waste slab is to receive a rough broom finish texture.
- E. Sand bedding **inside a rigid perimeter** may be acceptable only if stringent setting bed quality control measures are taken.
- F. All paver areas are to receive a clear masonry sealer.

Quality Control

- A. All adjacent grade elevations are to be taken into consideration when laying out these areas.
- B. Paver elevations are to be above the adjacent grade elevations.
- C. The drainage of adjacent site areas is not to be blocked by these paver areas.
- D. Completed paver areas will not retain water or exhibit ponding of incidental water.

Sand Bedding Of Pavers

- A. Excavated sub base natural material shall be graded to the proper configuration, compacted to 95% using mechanical compaction techniques. Walking on properly compacted sub base shall leave no foot prints.
- B. A 4 inch thick sub base course of crushed rock fines will be fine graded and mechanically compacted to 95%. This course will be uniformly planar as tested by a 10 foot screed in all directions.
- C. A 2 inch thick setting bed of washed mortar sand will be uniformly spread and compacted to 100%. Imbedded screeds may be utilized. Compaction is to be by mechanical means. When complete and properly compacted the setting bed will appear uniformly planar and will show no footprints when walked on.
- D. Install paver units with no gap or void between units.

SECTION 3: TECHNICAL GUIDELINES

- E. Upon completion of the installation of pavers, the paver surface is to be mechanically vibrated and any units that are not absolutely planar are to be removed and reset to acceptable tolerances.
- F. Additional sand is to be swept over the finished surface.
- G. The completed installation is to be gently washed using a light hose mist to wash dust off the paver surfaces.
- H. After the pavers have thoroughly dried for a period of at least 24 hours, a masonry sealer is to be uniformly applied to the paver surfaces. This colorless sealer is to be installed per the manufacturer's instructions.

32 84 23 - Sprinkler Irrigation Systems

Revised May 2013

Description

The DP shall provide a conceptual irrigation system layout as part of the schematic landscaping plan for budgetary inclusion and general coordination and approval by the ASU Grounds Department. The DP or their consultant should recognize and design irrigation systems based upon the premise of "xeriscape" landscaping design.

See Irrigation Master Plan for additional information.

Design Standard

- A. The contractor will be responsible for all blue staking before and during the project.
- B. A.N.S.I. Standards will be followed by contractors when applicable.
- C. Trenching
 - 1. Main lines shall be a minimum of 18 inches deep; auxiliary lines shall be 4 inches deeper than the bottom of the head being used.
 - 2. Lines bordering curbs, sidewalks or other hard surfaces shall be held 12 inches away to allow for maintenance and access to the lines.
 - 3. Sand shall be used in all trenches as bedding material for all PVC piping and also used as a covering for all piping. There shall be a minimum depth of 2 inches over the top of all piping.
 - 4. Pipe, drip tubing and control wire being routed under walks, roads or other hard surfaces shall be installed in schedule 40 sleeves.
- D. Pipe and Fittings
 - 1. All pipe for main and auxiliary (lateral) lines shall be schedule 40 (after valves). Ratings must be printed on the pipe.
 - 2. All fittings shall be schedule 40, pressure rated PVC fittings or better.
 - 3. Standard specifications for the piping materials shall include that the pipe shall be free from cracks, sunburn, discoloration, holes, foreign materials, blisters inside, bubbles, wrinkles and dents.
 - 4. If pipe is stored outside, it shall be protected from direct sunlight.
 - 5. NO galvanized or schedule 80 nipples, elbows or other fittings shall be used with any PVC pipe installations.
 - 6. ALL main lines shall be looped whenever possible so as to improve pressure and flow.
 - 7. PVC joints shall be primed and glued according to manufacturer's recommendations and wiped clean to avoid glue erosion.

SECTION 3: TECHNICAL GUIDELINES

8. Glued joints shall cure for 24 hours before pressure is applied to the lines.
9. ALL MAIN lines shall be first primed, then glued. All pipe 1 inch or larger shall be primed then glued. Glue used shall be Weld-On 711 and primer shall be P-70.
10. Warning Tape: Each line shall have warning tape provided directly above line, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. **All main lines shall have tracer wires for efficient locating.**
 - a. Provide Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility.
 - b. Provide detectable warning tape with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 2'-6" deep for non-metallic utility pipes, conduit or other underground services outside of building line.

E. Control Wiring

1. Wire size shall be UF-14 direct burial cable and shall be taped together in trench.
2. Control wires must be buried a minimum of 12 inches below finish grade.
3. Lawn, shrub, flower beds, desert and drip areas shall be valved separately and have separate stations on the time clock.
4. Wiring between the sprinkler time clocks and the electric remote control valves shall be color-coded and the neutrals shall always be white.
5. All connections to remote control valves and all splices shall be made with "PIN TITE" connectors and RAINBIRD PT-S5 sealer or pre-filled Pin Tite or approved equal.
6. All wire runs shall have expansion loops at all corners.
7. Electric lines shall be below pipe.

F. Valves

1. Electric remote control valves shall be Rainbird EFB-CP or Rainbird PES (PES should be of plastic design). All master valves shall be Rainbird EFB-CP and shall be of brass construction. Valves are to be labeled and valve boxes permanently marked.
2. Valves should be located, when possible, in grass or gravel areas and five feet from sidewalks, curbs or other hardscapes. Avoid locating valves in areas where curbs and walks or other hardscapes come together.
3. Where possible, valves shall be manifolded together, and each group of valves shall have a quick coupler or hose bib on the pressure side of the valve.
4. Valves shall not be smaller than 1 inch.

SECTION 3: TECHNICAL GUIDELINES

5. All valves shall be bedded on pea gravel and said pea gravel shall have a minimum depth of 6 inches.
6. Isolation valves up to 3 inches shall be ball type and constructed of non-corrosive plastic.
7. All valves shall be installed with unaltered manufacturer's Christy I.D. tags.
8. Valve boxes shall be Christy (or equivalent) with locking bolts, tan color in gravel areas, and green in grass areas. Bow-Smiths shall be encased in a 6-inch, round irrigation 'box.'

G. Clocks

1. New Maxicom clocks shall be housed in Rainbird Rainsafe enclosures. Clocks shall be manufactured by RAINBIRD and shall be MAXI compatible. The only acceptable clock is an ESP-SAT-TW.
2. Clocks shall be mounted OUTSIDE of buildings, tunnels, parking structures, equipment rooms, etc., for easy accessibility in emergencies.
3. All grounding for electrical/lighting protection, surge protection, etc., shall be completed as per RAINBIRD specifications. All flow sensors, transmitters, and pulse decoders shall be installed using RAINBIRD specifications.
4. The MAXI system has been installed on the ASU campus and the contractor shall make hard wire hook up to the nearest cluster control unit, usually closest to the phone equipment room. ASU sprinkler crew will assist in this hook up.
5. Flow sensors, transmitters and pulse decoders shall be required on all irrigation systems. (Minimum of one each per CCV).

H. Sprinkler Heads

1. All lawn heads shall be installed so that head-to-head coverage is accomplished regardless of wind and manufacturer's field tested specifications.
2. Sprinkler heads for lawn areas less than 30 feet wide shall be RAINBIRD 1804 with VAN nozzles. Final placement of these heads shall be a minimum 4-6 inches from the edge of hard surfaces. The heads shall be on swing joints. The use of polypipe swing joints is acceptable BUT the same manufacturer shall make the polypipe and PVC fittings.
3. Heads for narrow strips of lawn shall be RAINBIRD 1804 with appropriate nozzles. Heads for shrubs and flowers shall be RAINBIRD 1400/1500 or RICHDEL hand adjustable bubblers.
4. Heads for areas larger than 30 feet wide but having some trees shall be RAINBIRD 5000 or HUNTER PGM.
5. Heads for very large open lawn areas shall be RAINBIRD FALCONS.
6. Prevailing wind direction, location of mounds, and location of trees shall influence placement of all heads.
7. All sprinkler heads shall be on swing joints.

SECTION 3: TECHNICAL GUIDELINES

8. All lines shall be flushed before the sprinkler heads are installed.
9. The sprinkler system shall be balanced and all heads plumbed to vertical before acceptance by ASU.

I. Drip Irrigation

1. The use of drip irrigation or 1/2 inch black poly tubing on any ASU project is discouraged, and should only be used where runoff of sprinkler water might be a problem due to extreme elevation/grades.
2. Drip emitter type shall be limited to AGRIFIM SUPER-FLO or BOW-SMITH. Spaghetti lines shall be no longer than 8 feet long, and shall be 1/4 inch diameter only. Lines shall be buried until about 2 inches to plant and shall be staked. Bow-Smiths shall be encased in a 6-inch, round irrigation 'box.'

J. Backflow Prevention

1. Reduced pressure backflow preventers shall be installed at all connections to water distribution mains.
2. Reduced pressure backflow preventers shall be manufactured by FEBCO.
3. By code, back-flow preventers must be a minimum of 12 inches above grade.
4. Immediately downstream of the back-flow preventer shall be a water meter or MAXI compatible flow sensor of appropriate size. Flow sensors shall be 2 feet before and two feet after any joints to insure accurate readings.

K. Drawings

1. Prior to construction, preliminary design plans must be submitted to ASU Grounds for approval. At the completion of each project, accurate, reproducible, as-built drawings will be provided to ASU Grounds Services. AutoCad compatible files (*.dwg, *.dxf) will be provided so the sprinkler system may be entered into the campus infrastructure data.

L. Miscellaneous

1. When designing and installing new sprinkler systems at ASU, the following should be observed: 1) When placing sprinkler heads in lawn areas having sidewalks, driveways, etc., all the hard surfaced areas shall be lined with RAINBIRD 1804 sprinkler with van nozzles; rotary-type sprinklers may be used to fill in the large open areas. 2) If the area being designed is an older part of campus with many mature, invaluable trees, care must be taken to ensure that no damage is done to the bark of trees due to water impact from sprinkler heads. 3) **All designs must be submitted to the ASU Grounds Services (or the Landscape Architect Coordinator at the ASU at the Polytechnic campus) for approval before installation proceeds.**

32 40 00 - Gabions*Revised May 2013***Description**

This section defines the use and implementation of the rock filled wire baskets as a functional and design item in site development for new projects. The use of gabions will be reviewed on a project basis but primarily will be used on the Polytechnic campus.

Design Standard

- A. The design and construction of the gabion baskets will conform to the manufacturer's literature and all associated appurtenances. Wire for the manufacture and assembly of gabions shall be non-galvanized and non-coated black steel wire and Welded Wire Mesh (allowed to rust naturally) and shall meet or exceed all of the following requirements:

Description	Requirement
3"x3" (9 ga. - 0.144 in. min.) Welded Wire Fabric	ASTM A185
9 ga. Pre-Formed Stiffener	ASTM A82
9 ga. Spiral Binder	ASTM A82
13.5 ga. Tie Wire (temporary)	ASTM A641

- B. Suggested manufacturer: ARTWELD GABIONS as manufactured by Hilfiker Retaining Walls, 3900 Broadway, Eureka, CA. USA 95501. <http://hiltiker.com> or approved equal.
- C. Sample mockups shall be erected two complete gabion mockups utilizing two foot (2') basket heights, including stone placement & reinforcing posts, for review and approval of both technical and aesthetic installation results by OUA.
- D. Gabions shall be of a single unit construction in the following sizes: 3' width x 3' height x 6' (max.) length and 2' width x 2' height x 6' (max.) length; internal cells of equal three (3) foot spacing with diaphragm panels made of the same wire mesh used for the gabion body. Each gabion shall be fabricated with the manufacturer's spiral binders connecting the panels at the base.
- E. The base, ends, sides, and lid shall be fabricated from 3" x 3" x 9-gauge, non-galvanized, non-coated, black (allowed to weather naturally) Welded Wire Mesh and connected in such a manner that strength and flexibility at the connections are at least equal to that of the wire mesh.
- F. The gabions shall be fabricated in such a manner that they can be assembled at the construction site with Spiral Binders and pre-formed hooked stiffeners to form rectangular baskets of the specified size.

SECTION 3: TECHNICAL GUIDELINES

- G. The length, width, and height of the gabion assembly shall not vary more than 5 percent from the dimensions shown on the plans.
- H. Each shipment of gabions to a job site shall be accompanied by a Certificate of Compliance.
- I. Rock for filling the gabions will be 100% passing 6" and 2% or less passing 3". Rock to be clean, free of nicks and fractures and placed in gabions per the manufacturer's instructions.
- J. If required, soil filtering fabric shall be a non-woven, Geo-Textile Fabric, 8 oz./square foot fabric cloth.
- K. The exposed face or faces of the gabions are to have the rock handset. As much as possible, the flat face of a rock is to be tightly spaced against the wire mesh. Proper rock placement will provide a "stacked stone" appearance. Rock behind the face stones can be randomly placed in a manner to minimize voids and settlement.
- L. At curved or radiused walls - modify the faces of gabion baskets to achieve a continuous radius. Retain the front face (outside radius) of the basket to maintain the basket's standard horizontal face dimension along the outside wall radius. Configure the horizontal length of the back basket face (inside radius) to conform to the walls inside radius. Curves are to be smooth and even in appearance.

32 90 00 - Landscaping

Revised May 2013

Description

The intent of this section is to provide a general scope for all landscape development for campuses within the ASU system. These are broad enough to allow for modification by the DP if the project calls for specific installation requirements that are not addressed herein.

Design Standard

General

- A. All planting material for new and renovation projects are limited to the selection of materials outlined below or approved by OUA, and should be scaled, located and/or placed in a manner that both supports and furthers the project's architectural intent, Campus aesthetics, and the health of the plant. Special consideration should be given to specialized collections and rare plants. All endangered and threatened species are required to be permitted and tagged by the Arizona Department of Agriculture, Native Plant Division.
- B. The DP's schematic landscape plan shall clearly indicate the species, number, size, color and general design intent of all landscaping materials proposed. The use of photographs in the design presentation(s) corresponding to the plan is highly encouraged. **A copy of the final landscape design plan should be submitted to ASU Grounds for all installations at the completion of the work.** Plans should show irrigation design, context photographs and hardscape features.
- C. The DP's design should **carefully consider and avoid any feature or planting material that may present a physical barrier or hazard, nuisance or maintenance problem when fully matured, or at any time during the course of its life.**
- D. The approximate life expectancy of plant material in a healthy visual state should be seriously considered in selection.
- E. A water budget shall be calculated for all landscape planting derived from water requirements for each specific planting and submitted for approval and record to OUA prior to construction.
- F. Lawns
 - 1. Lawns shall be established by cut sod or stolons. In either case, the soil shall be thoroughly roto-tilled to a depth of 12" and leveled to receive grass. For sod, soil shall be 1/2 inch lower than existing grass, to ensure new sod is level with existing grass.
 - 2. Lawn grass shall not be used in any planting strip less than 12'-0" inch wide.
 - 3. Lawn shall only be used where it is of a useable size fully accessible and maintainable for irrigation, mowing, fertilizing and pest control.

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4. Seed shall be hybrid Bermuda grass (*Cynodon x.*); sod shall be Midiron Bermuda grass, strongly rooted, not less than 2 years old and machine cut to a pad thickness of 3/4 inch; wintertime overseeding shall be with annual Rye grass. Installation of sod will be coordinated with seasonal factors.

G. Trees and Shrubs

1. Trees in **pedestrian walkways and/or adjacent to sidewalks shall be single trunk** (i.e., tree should have a single-trunk for at least 5 feet before branching out); **or low breaking specimens** The “face” of the tree will be oriented parallel to the walkway and will allow for the tree to grow without impeding the walkway. Trees in lawn areas shall have tree guards acceptable to ASU Grounds Services. Plants that encourage pests or rodents are highly discouraged. ASU will review and inspect plants proposed for use on campus and reserves the right to refuse specific plants that they find are not acceptable. Root bound trees are **not** acceptable and will be rejected by OUA or Grounds.
2. All plants shall be types proven to be hardy for the area and situation.
3. The use of 15 gallon trees shall be discouraged in mature landscape areas, but can be considered for back-of-house installations.
4. Minimum caliper size for new trees shall be per Arizona Nursery Association standards for box size.
5. Minimum box tree size shall be 24 inches for non specimens and 36 inch for specimens (or larger in key areas).
6. Trees planted in lawn areas is discouraged; however shall be provided with 24 inches of bare, sod-free soil beyond and around the full circle of the tree. The cambium layer shall never be buried. Root crown shall be 1 inch above grade. Temporary berms for initial water are acceptable, depending on site conditions and will be removed by the contractor at the end of the warranty period.
7. Trees selected for planting in an Arboretum designated display or collection area shall be reviewed and approved by OUA.
8. Deciduous trees shall be planted no closer than 8' from any walk or drive; evergreens no closer than 2' greater than the mature radius of branching. **Trees with low, horizontal growth habit, or trees with thorns shall not be planted next to streets, bike paths or lanes, or next to sidewalks.**
9. All trees and shrubs shall be planted in holes dug to specifications recommended by the Arizona Nurseryman's Association and the University of Arizona Cooperative Extension Service.
10. All 24-inch (and above) box trees or palms shall have perforated, capped and vented, schedule 40 air sleeves. Palms will require two, while 24” box trees and larger will require one per pit.
11. All trees 24” box and larger will NOT be stacked at the time of planting and all nursery stakes are to be removed prior to the contractor leaving the site, unless otherwise noted.

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12. The use of structural soil is highly encouraged for tree plantings in plaza areas.

H. Obstructions

1. Isolated post in lawn areas shall have a concrete mow strip minimum 7 inch around the post.
2. Obstructions (curbs, buildings, walks, etc.), adjacent to lawn areas, shall have a mow strip and/or apron, a minimum of 12 inch to eliminate unmowable grass.

I. Parking Lots

1. Trees planted in median strips shall be of a type that permits pruning to give a full 8' clearance at curb side. Trees in these areas should have an upright or longitudinal growth habit. The “face” of the tree will be oriented parallel to the parking space.
2. Medians shall be planted with a hardy ground cover.
3. One tree shall be required in new surface parking lots for every 40 parking spaces. The goal would be to have the trees within the parking lot and not just at the perimeter to mitigate atmospheric heating.
4. The use of structural soil is highly encouraged in parking lots.

J. Soil Preparation

1. All soil and top soil used as a planting media shall conform with the following:
 - a. all soil components shall be tested by a testing laboratory for conformance with the specifications;
 - b. if herbicide contamination is suspected, then a radish/rye grass growth test shall be performed;
 - c. mulches shall be finely ground decomposed pine bark;
 - d. ANY manure is NOT acceptable;
 - e. chemical additives shall be of agricultural grade, used as necessary to maintain a pH at 6.5 to 8.0;
 - f. planting media shall be compost as purchased by the contractor and from the ASU campus provider. OUA and/or Grounds will provide contact data as required.
 - g. commercial bagged fertilizer for trees, shrubs and ground cover shall be Ammonium Phosphate (16-20-0), pelleted form and contain a minimum of 16% nitrogen and 20% phosphoric acid.
2. Weed barrier shall be used in areas covered by decomposed granite and in other areas determined by ASU Ground Services, and shall be woven polypropylene (Baycor #47919 or equivalent), which allows water to penetrate yet keeps weeds in check.

K. Maintenance

SECTION 3: TECHNICAL GUIDELINES

1. Maintenance shall begin immediately after each portion of lawn and each plant is planted, and shall continue in accordance with the following requirements:
 - a. Lawns that have been planted shall be protected and intensively maintained by watering, mowing, fertilizing, and replanting as necessary through a minimum of 90 calendar days or longer, if necessary, to establish a uniform stand of the specified grasses and until acceptable.
 - b. New plantings and groundcovers shall be protected and maintained until the end of the lawn maintenance period or until final acceptance. Maintenance shall include water, fertilizing, weeding, cultivating, mulching, tightening and repairing guys, removal of dead materials and resetting plants to proper grades.
 2. Specifications shall require the GC to keep and store, at its own expense, sufficient quantities of mix for lawn to repair any settling, or to adjust grades throughout the warranty period.
 3. Specifications and notes on the landscape drawings shall require the GC to maintain for a minimum of 90 days after acceptance, and accept all responsibility for all plant material until final acceptance of the Work by ASU (exclusive of replacement under the warranty period).
 4. Maintenance schedules shall be submitted to and approved by and kept on file with ASU Grounds for the 90 day period prior to final acceptance.
 5. Pruning shall be limited to the removal of dead plant material or growth that would harm the overall structure and form of the plant.
- L. Decomposed Granite:
1. Decomposed granite at ASU shall be 1/2-inch screened or washed material as approved by OUA.
 2. If other decomposed granite is approved for a specific project, then specifications (including description, size, color, samples and suppliers) shall be furnished to OUA and ASU Grounds.
 3. Wash areas, bioswales, basins and desert cobble areas will have an initial cover of 6" – 8" rip rap, tamped into place and then top dressed with 3" minus. All areas then will be water settled.
 4. The decomposed granite colors approved for each campus are as follows:
 - a. Tempe – Saddleback or Express Brown
 - b. Polytechnic – Cherokee Sunset or Express Rose
 - c. Downtown Phoenix – Saddleback or Express Brown
 - d. West – Madison or Express Gold
 - e. Lake Havasu – Aztec Gold